POWER

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Time To Retire?

Now that which decayeth and waxeth old is ready to vanish away.—*St. Paul.*

THERE comes a time in the life of any piece of apparatus when its owner had better begin to figure how much longer he can afford to use it.

This is particularly true in the case of power-plant apparatus.

Within the useful lifetime of an engine or boiler that has had good care, there have been so many improvements, such increases in efficiency that a plant reorganized on modern lines will often save a handsome dividend on its own cost plus that portion of the cost of the old plant that has not been written off.

In a recent issue of POWER was a test of a boiler plant of moderate size in an industrial establishment. The efficiency attained was over eighty per cent.

The average efficiency of such plants is well under sixty per cent.

What would it amount to in your own case if you could get along on one-quarter less coal than you are using?

Modern methods and apparatus make possible the effective use of fuels previously usable only with difficulty. Can you reduce your cost per ton as well as the number of tons burned?

Modern prime movers require only one-half the steam per kilowatt-hour that many of those still in use are consuming. Are yours eating their heads off?

Heat, like water, generates power by falling. Its temperature level in the boiler furnace is high. In the old low-pressure days we lost a lot of its potential fall. Have you considered what an increase of steam pressure and temperature might do for you?

You, engineer-in-charge, have you considered the possibilities of your own case in these directions? If not, you had better be about it. Some day the Boss may wake up and want to know. And if you cannot tell him, somebody else will. And that may hurt your feelings.

F. R. Low

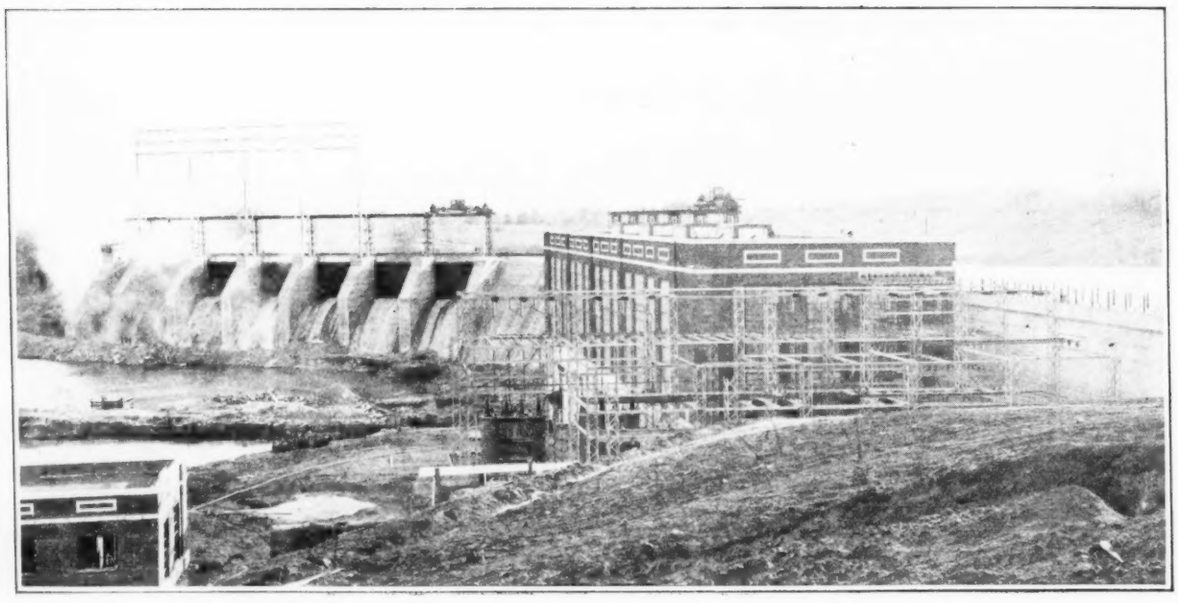


Fig. 1—Downstream side of power house and dam

The Catawba Hydro-Electric Plant Of the Southern Power Company

New Catawba Plant of 75,000-Kva. Capacity Replaces Former 10,000-Kva. Plant—New Dam Increases Head from 25 to 70 Feet

TO KEEP pace with the rapid increase in electrical demand in industrial North Carolina, the Southern Power Co. has recently completed another large hydro-electric plant on the Catawba River in South Carolina and about twenty miles south of Charlotte, N. C. This 75,000-kva. development replaces the former 10,000-kva. station which was built at this point in 1904. The smaller plant was on the east side of the river, while the new station has been built on the west side. The old dam foundation was used for the location of the spillway and the new dam made longer and higher, so that the area of the reservoir is greatly increased and the gross head is 70 ft. The spillway is shown at the left in Fig. 1, which is a view taken from the downstream side of the plant.

As will be seen from Fig. 3, the four turbo-generator units are placed in a line along the building length. The intake to each of the turbines consists of two openings formed in the concrete masonry. Fig. 4 shows the forms for the intakes and flumes being prepared for the concrete. Each of the flume openings contains a rectangular butterfly valve made by M. H. Treadwell Co., consisting of a cast-steel girder with bronze-bushed trunnions, to which are bolted the cast-iron wings. A sectional cast-iron frame embedded in the concrete provides the seat with which the valve contacts when closed. Each gate is operated by a Treadwell hoist located on top of the bulkhead and as shown in Fig. 5. The connecting rod is made of 9-in. extra-heavy pipe and, since both in opening and in closing the stress on the rod is tensile, there is no danger of buckling. However, to prevent this trouble when the valve is just closing, causing the rod ordinarily to be in compression, there is a slotted connection at the crosshead to permit an overtravel of the rod. There is a control station for each hoist on the bulkhead, and a second control on the benchboard within the power house.

Each of the four units consists of an Allis-Chalmers vertical single-runner Francis type 100-r.p.m. turbine built for a 70-ft. head, driving an 18,750-kva. 6,600-volt three-phase 60-cycle General Electric alternator, with a direct-connected exciter. The revolving element is supported by a 46-in. Kingsbury thrust bearing at the top of the alternator, and the turbine guide bearing is of the lignum-vitae water-lubricated type.

Each turbine is equipped with an Allis-Chalmers oil-operated governor. The governor flyballs are mounted on the vertical turbine shaft just below the coupling to the alternator shaft. By raising or lowering a ring upon which rests the inner edges of the governor bell cranks, the oil governor mechanism is shifted to cause the turbine gates to be opened or closed as the case may be. The governor stand is on the generator-room floor and the oil pumps, receiving tanks and oil-pressure tanks are in the basement adjacent to the machines. To stop a machine, the engineer operates a handwheel on the governor which closes the gates and slows down the turbine. When the gates are closed to a predetermined point, this being about one-tenth gate opening, a contact on the governor mechanism causes a relay to throw the main generator switch, which, through a second relay, opens the field switch. There is an emergency control on the benchboard by which the operator closes the circuit of a small motor on the governor

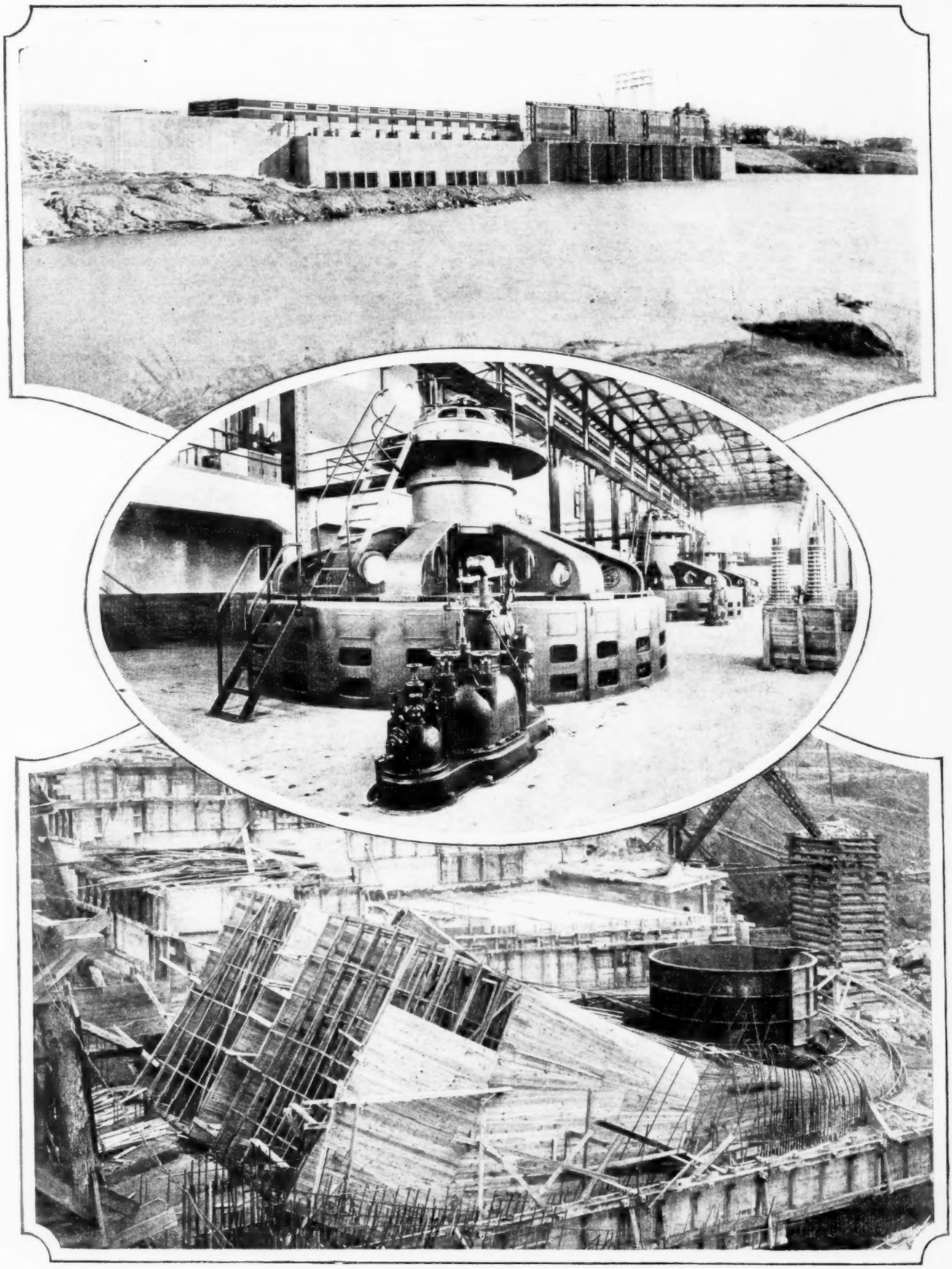


Fig. 2 (Top)—Upstream side of power house and dam; forebay partly filled. Fig. 3 (Center)—Generator room contains four 18,750-kva. 6,600-volt 60-cycle units. Fig. 4—(Bottom)—Forms for the two penstocks and scroll case for one of the turbines

stand, which, through a train of gears, causes the governor to close the gates to one-tenth opening whereupon the remainder of the stopping operation is continued as previously described.

To insure quick stopping of the unit in case of emergency, there is an air-braking system. A set of cylinders, each containing a plunger with a brake shoe at its top, is placed below the generator; by opening a valve, air from a receiver raises the plunger, causing the brake shoe to bear against the lower edge of the rotor rim. It is usual to brake the unit on stopping when its speed drops to about 10 r.p.m. If the wheel is permitted to revolve until it comes to a rest automatically, the speed is so slow that the oil film on the thrust bearing will not support the weight. If it is desired to lift the weight off the thrust bearing, the cylinders are used as air jacks. The air supply is obtained from two 2-cylinder street-railway type air compressors direct connected to motors. These compressors also supply the air to charge the governor oil-pressure tank.

The guide bearings of each generator are oiled under pressure, the oil pump being geared to the vertical turbine shaft and located just below the generator. The oil, after passing through the bearings, flows by gravity to a filter and receiver placed below the generator and inside the concrete housing.

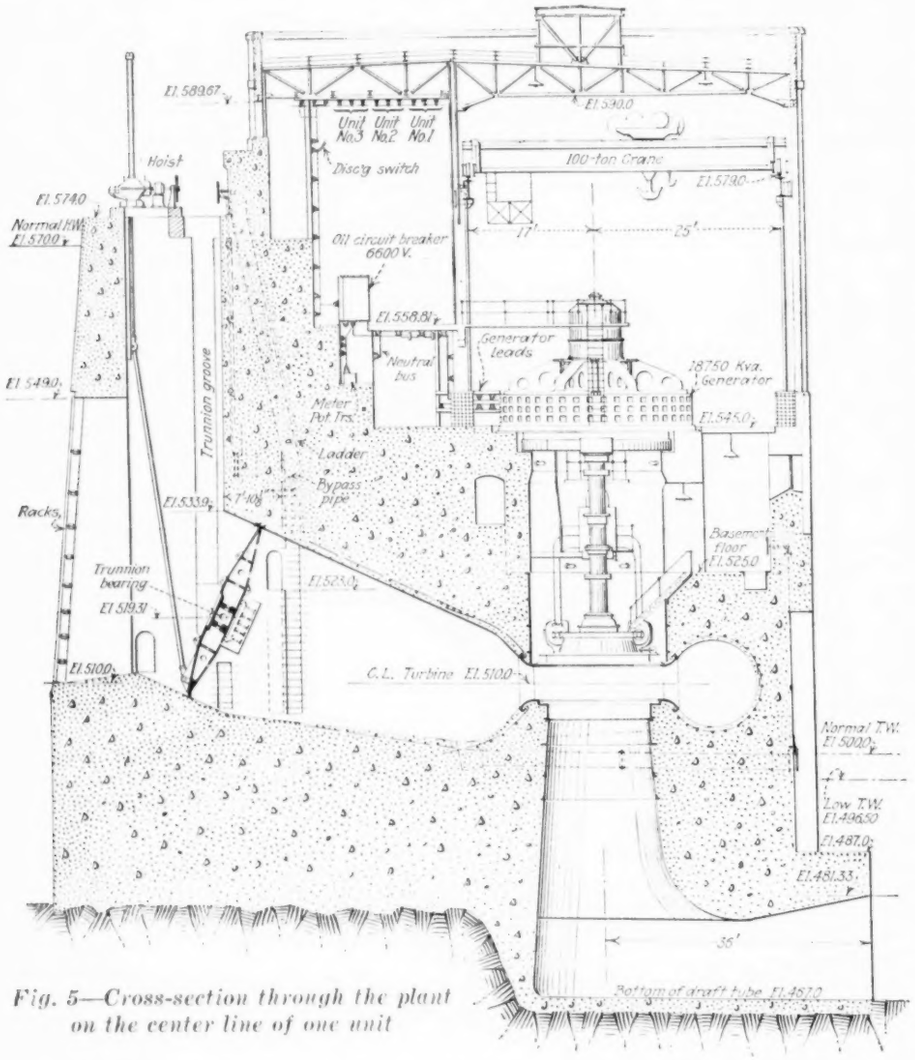


Fig. 5—Cross-section through the plant on the center line of one unit

The leads are brought out from each generator on the up-stream side and are tied to the high-tension bus lines through a disconnecting switch placed on the mezzanine floor, as shown in Fig. 5. The high-tension buses run along below the roof members to the station switches outside the building. They are of flat copper placed 18 in. apart with a curtain of asbestos board between. The station buses are arranged so they can be connected to whichever generating unit is running. The neutral bus runs along the ceiling below the mezzanine back of the generators.

In the basement are placed two 8x6-in. two-cylinder vertical air compressors direct connected to 10-hp. motors. These machines supply air for cleaning equipment and also air to the trash racks. Trash collects along these racks and air lines are placed at the bottom of each rack; by agitating the water the trash is raised to the surface and is then pulled to the trash sluiceway. This cleaning can be done only when the turbine is idle since the velocity of the water causes the trash to wedge against the bars.

The use of brooms has been eliminated through the installation of a vacuum system. A pipe line is run into the draft tube of each turbine, and the suction is ample to draw all dirt through the vacuum-cleaner hose.

The switchboards are placed on the mezzanine floor at one end of the building. There is a benchboard for the control of the station equipment, a switchboard mounting recording ammeters and voltmeters, as well as relays. A third switchboard controls the various switches of the outdoor transformer station.

In the past it has been the policy of the Southern Power Company to contract all its plant construction. In the case of the Catawba plant the entire work was carried out by the engineering force of the power company. For the data in this article, *Power* is indebted to William S. Lee, chief engineer, Southern Power Company.

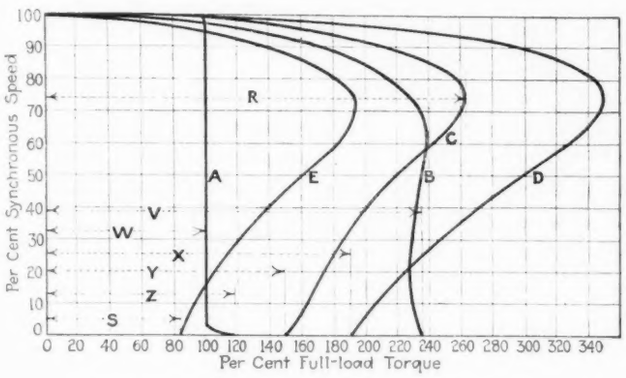
When a Transformer Can Be Set Up immediately in its permanent location and filled with oil, it is advisable to do so even though it will not be put into service for some time. If this is not convenient, it should be stored in a dry place having no rapid or radical temperature changes, and if possible immersed in dry transformer oil. The transformer should not be stored or operated in the presence of corrosive gases, such as chlorine, etc. If stored out of doors, it should be thoroughly covered to keep out rain.—*Instructions of the Electric Power Club.*

Preventing Overmotoring of Conveyors

By R. F. Emerson*

THE evils of low power factor, higher first cost, etc., due to overmotoring on alternating-current systems, should be avoided wherever it is possible to do so by making a careful study of the conditions of operation. There are some applications where the reasons advanced for overmotoring seem very reasonable, but even here there often exists some way for avoiding this difficulty.

Conveyors are probably overmotored to a greater extent than any other type of material-handling machinery. Different reasons are advanced by manufacturers for overmotoring conveyors. In the case of



Speed-torque curves of squirrel-cage motors and conveyor

A—Speed-torque curve of conveyor. *B*—Speed-torque curve of double-squirrel-cage motor. *G*—Speed-torque curve of general-purpose squirrel-cage motor. *D*—Speed-torque curve of over-size general-purpose squirrel-cage motor. *E*—Speed torque curve of motor *C* when started with compensator.

conveyors handling bulk material such as coal, coke and ore, they usually are installed out of doors, and often are neglected. Sometimes they are not lubricated and frequently shafts get sprung or out of alignment. This causes the friction load to increase and the amount of static friction to be overcome when starting may become so great that, whereas a 10-hp. motor may handle the load after it is operating, it may require 20-hp. torque to break the static friction at starting. Since squirrel-cage motors are generally used, and the power companies usually require some form of starting device, the net result is that instead of a 10-hp. being used, a 15- or possibly a 20-hp. motor is installed.

It is unfortunate for applications of this nature that the torque developed at starting by the standard general-purpose squirrel-cage motors is so much less than what the motor can produce after it gets up to 70 per cent or 80 per cent of its synchronous speed. An inspection of curve *C*, in the figure, shows a typical speed-torque curve of a general-purpose squirrel-cage motor. The torque *Y* exerted at starting is considerably less than *R*, which is the maximum torque the motor can develop after its gets up to approximately 75 per cent speed. It will be noted that *Y* does not show any too great margin above *Z*, the torque required to break the static friction of a conveyor whose speed-torque curve is denoted by *A*. If the motor is larger than 5 hp., the local power company will probably require a compensator to be used, which will result in reducing the available starting torque to *S*, which will be insufficient to break the starting friction and get the conveyor machinery moving. As a result, conveyor builders will recommend a larger motor, which may have a speed-torque curve *D* and will be able to start the machinery under all conditions of operation, but which will operate at considerably less than full load after it gets running, with the resulting lower power factor and lower efficiency than would be the case if the motor represented by curve *C* could be used.

The Double Squirrel-Cage Winding

The advent of the double-squirrel-cage winding provided a motor that gets away from the low starting torque of the general-purpose squirrel-cage motor and takes approximately 70 or 75 per cent as much current at starting as the former. This motor has exactly the same appearance as the standard squirrel-cage motor, practically the only difference being in the rotor, which has two squirrel-cage windings, one high resistance and the other low resistance. A representative speed torque curve of a 6-pole, 7½-hp. 1,200-r.p.m. motor of this type is shown by curve *B*. The amount of starting torque *V* available for breaking the static friction of the conveyor leaves no doubt of the ability of this motor for starting the conveyor under the most adverse conditions.

If this motor is properly applied, its full-load torque will be equal to *W*, which is the torque required for operating the conveyor, and the conveyor owner will not be obliged to pay the penalty of low power factor and low efficiency, due to a partly loaded motor. All sizes of these motors are adapted to full-voltage starting, that is, without using a compensator or resistance starter, but if conditions such as belt or chain drive, danger to conveyor mechanism, or anything of this sort forbid applying full-voltage torque at starting, it is feasible to use either a compensator or resistance starter, which will reduce this starting torque to a point that will just get the machinery turning over before applying the full-voltage torque of the motor. There should now be no excuse for overmotoring bulk material-handling conveyors on account of the necessity for overcoming high static friction.

Belt Conveyors Overmotored

Belt conveyors for handling packages are also overmotored, but for different reasons than usually advanced in the case of conveyors handling bulk material. A package-handling conveyor is usually installed indoors where the equipment gets better attention, and high starting torque is not so essential as in the case of other conveyors. When a package conveyor is sold, the manufacturer usually has some information from the customer, relative to the number of packages to be handled at a given time, also the weight of the packages. It is easy for the user to increase the weight and number of packages handled, with the result that if the motor has no overload capacity, it will be burned out. An example is the case of a package conveyor in a department store, the motor of which may work satisfactorily all the year until the Christmas season, when the overload due to the Christmas shopping will cause trouble. Likewise a sorting conveyor in a post office may be subjected to the same kind of an overload during the Christmas rush. Also in the case of a plant

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handling packages of a given size and weight, it may develop that when the conveyor is ordered, it is estimated that a certain number of packages per 100 ft. of conveyor belt will take care of the requirements of the plant.

Many conditions may arise, which cause the number of packages handled to be increased, one being the natural growth of the company's business. For these reasons, package-conveyor manufacturers consider it essential to overmotor their conveyors so as to take care of future conditions. It may not seem reasonable for a purchaser to blame a conveyor manufacturer because the motor cannot pull twenty packages per 100 ft. of conveyor belt, when his original order for the conveyor definitely specified ten, but at least one such case has come to the writer's attention. Consequently, the conveyor builder considers that he is avoiding trouble by overmotoring his equipment. Furthermore, the cost of the 10 hp. motor is not much greater than that for a 7½-hp., or a 15-hp. does not cost enough more than a 10-hp. motor to warrant his inviting trouble due to the conveyor's being equipped with a motor not large enough to pull the load under all emergencies.

Spare Parts to be Stocked in Oil Engine Plants*

By A. B. Newell†

THE problem of oil-engine spare parts, to a certain extent, solves itself automatically, as many other problems have solved themselves, with experience as a teacher. This is generally an expensive method, and some purchasers who have learned by that means have found it discouraging. Naturally, the greatest expense—we could say unnecessary expense—in this connection has not fallen to the lot of the ones who have purchased spares too freely. On the contrary, those who have been over-anxious to avoid heavy expense, and as a result cut down on the spare list, have in the long run paid dearly.

Lack of Understanding Responsible for Mistakes

A lack of understanding of oil engines, and an overconfidence in claims made by misguided salesmen, who feel that to recommend a suitable list of spare parts is to admit that the engine will demand certain replacements, may have been responsible for some of the mistakes that have been made. That oil engines are not comparable to steam engines in this respect should be readily apparent to anyone making a careful comparison of both types.

Oil engines of today do not require as many spares as did those of ten years ago, and another ten years will see further reduction. We have better engines, more capable engineers, higher grades of lubricants and fuel, as well as innumerable methods and instruments for checking up on performance. In fact efforts are always toward making the engine foolproof, while manufacturers are better prepared to make prompt shipments of parts when needed. Now that they have parts made up and ready for shipment, the plant owner who suffers a breakdown does not need to wait for castings or forgings to be made and machined before shipment can be made. Despite all this, there are often certain inherent weaknesses in the engine-room staff and vulnerable spots in the engines which must be taken into account when considering spare equipment.

The engineer is still an uncertain quantity, although the engine is more dependable. If we attempt to insure against human fallacies and play 100 per cent safe, a spare engine could be made from the list of spares carried. As for the engine, an almost complete prediction of what will be required, and when, can be made. A compromise must be made, and in so doing, sound judgment must be the guide.

Small Engines More Numerous than Large Ones

Throughout the country we have many more small oil engines than large ones. Most of these are very simple and sturdy little machines, yet they require an extra fuel valve or two, some spare fuel pump valves, springs and plungers, a complete set of all other springs, some scavenging pump valves, an extra starting valve and cage, and a set of piston rings. The low cost of obtaining and maintaining such a list tends to make plant owners and engineers contemptuous of their value, or they feel that such items may be supplied by local machine shops.

They are wrong. When such parts are needed, they are needed badly, particularly where a shutdown is expensive. The local machine shop is in no position to supply such parts economically, if at all. With the exception of some of the springs small parts are made of special metals, some of which are commercial alloys and others treated in the plant of the engine builder. There is no secret process, and it is only a lack of knowledge, sometimes difficult to obtain, which prevents the machine shop from being able to supply suitable materials.

If the engine is to be sent abroad, other items such as a piston, cylinder head, bearing shells, crank boxes, top and bearings, gudgeon pins and perhaps some other parts are needed. If it is a four-stroke-cycle engine, exhaust and air-inlet valves should be added, as well as air-compressor parts, particularly valves and rings, if it employs the air atomization method of fuel injection.

Spares for Large Engines

With engines of larger power the spare list assumes a different aspect. The regular run of spares such as has been mentioned will be required. But large capacity generally means a multiplicity of cylinders and the number of parts will be governed by the number of such cylinders, for I am now referring to what, for want of a better word, I am calling the vulnerable parts of the engine and which become worn or burned up after a certain period of use, and not to such items as should be carried as a precautionary measure against breakages or unavoidable accidents which may be chargeable to neglect.

Throughout the entire mechanism the greatest departure from steam-engine practice lies in the fact that combustion takes place within the cylinder and the greatest departure from ordinary gas- or gasoline-engine practice lies in the employment of considerably higher pressures and temperatures, as well as a greater duration of combustion.

These features which, while imperative for fuel economy, are also the cause of trouble so far as maintenance is concerned. Certain frail parts, such as fuel

*Contributed to the Oil and Gas Power Conference, April 19-24.
†American-Brown-Boveri Corp.

nozzles and valves, last but a limited time and their periodical replacement is known to be a routine maintenance expense. Piston rings may also be considered as perishable in service.

Then there is the question of pistons, cylinder heads and cylinder liners. Since they are directly exposed to intense heat and the manner in which such heat is controlled determines their life, and we can scarcely foresee just how carefully this will be controlled, no one can truthfully say that at least one of each is not almost necessary for the sake of safety.

Well removed from the heat of combustion are other parts such as are found in the fuel pumps and air compressor. The fuel pump is made up of many small working parts which must be so exact in their functioning that no wear of any consequence can be countenanced, yet these parts do wear. It will be observed that there is a certain uniformity of such wear on similar parts. Therefore, if the engine has six cylinders, it would be necessary to insure against the interruption of six fuel pumps, by having valves, springs, plungers, etc., for the full number of such units.

Care of Valves, Etc.

Air-compressor valves, valve seats and cages require periodical attention. Such attention insures good service. Although there is no natural tendency of the compressor to remain in good order, fortunately, it will work and give a fair degree of satisfaction, although not exactly right, often making possible an uninterrupted power output of the engine for a considerable time while giving warning of its impending trouble. This is an advantageous leeway, but it is limited and must not be abused, for valve troubles, if deliberately neglected too long, tend to affect other parts as well.

With the valves are included seats and springs, all of which at best do not last very long, particularly those of the high-pressure stage, and a complete set ready for use at all times is not just an insurance against breakage and incidental losses, but a means of preventing undue time losses during the overhaul and reconditioning of those in service.

Air-compressor piston rings wear out, sometimes quickly and unexpectedly, particularly when foreign substances find their way into the suction line. Sulphur fumes, which may escape with exhaust gases into the engine room, may form dilute sulphuric acid in the cooling coils and act on the rings; in such instances spare rings will save the day.

Small Parts Should Not Be Neglected

We must not overlook the fact that neglect of small parts leads to trouble with large ones. Fuel pumps, atomizing devices, valves and even the compressor, when in bad condition will react upon pistons, rings, cylinder liners, cylinder heads and in some engines, the bearings as well.

To charge all mistakes in operation to indifference is not fair, for we all make mistakes; therefore, in ordering such parts as pistons, cylinder liners and heads, crank and main bearings, we are only insuring against time losses which may be very expensive and may strike any plant at any time.

Smoke at the exhaust pipe means trouble, as does an unequal load distribution among the various cylinders, or a careless manner of controlling the cooling-water temperature. Few plant owners can have positive knowledge of these details of operation and without it they cannot prevent troubles. But the plant owner is not the operating engineer.

Generally speaking, the engineer who has an intimate knowledge of these conditions, is less at ease than his employer and asks for protection, tacitly admitting that he is not perfect and may fail. When he is willing to admit his fallability, surely his employer should listen to reason and protect himself.

Removal of Ice and Trash in Vertical Turbine Installations

In hydraulic plants located on rivers of heavy flow, subject to the breaking up of ice, the trash racks are exposed to obstruction by the ice. For discharging the ice, sluices are generally provided, but unless these are numerous this arrangement is not very efficient for the removal of large quantities of surface ice. When the turbines are of the vertical type design that tends to be well adapted to large flow and low head, patented by M. Rene Koechlin, Zurich, Switzerland, and described in

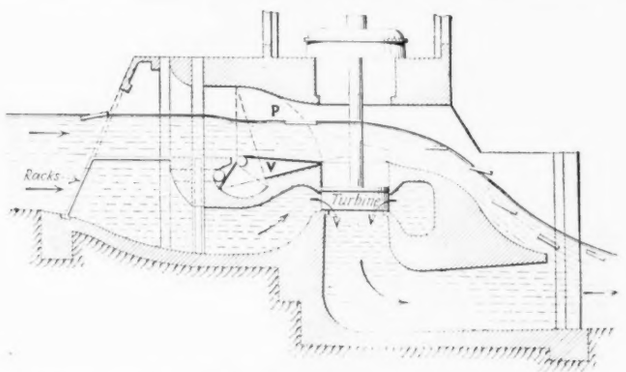


Diagram showing a proposed way of passing ice and trash through a water-power plant

an article in *Le Genie Civil*, permits the removal of ice and floating bodies over the entire length of the building, without obstructing the turbines and without requiring supplementary canals or lengthening the turbine room. Its adoption is contemplated for the plant projected on the upper Rhine at Kembs, near Strasbourg.

As the accompanying schematic diagram shows, the trash racks are lowered below the level of the water in a manner to permit the surface water to pass directly above each turbine, carrying with it the ice and other floating bodies. The material that is stopped by the trash racks will be carried up by the rakes when cleaning the racks and also carried away by the upper current.

Each passage *P* is closed or opened according as the level of the river rises, by an automatic valve *V* which opens out of the way into a pocket. The regulation of the valve is such that the flow of the river remains constant whatever be the degree of the opening of the turbine.

The Proper Time for Cleaning Flues of heating boilers is in the spring. If soot is allowed to remain in steel smokestacks all summer, it becomes damp and cakes and at the same time the sulphur it contains attacks the pipe and corrosion sets in.

High Load Factor and Process Steam Demand Enables Extraction Turbine to Save Over $50,000 a Year

By H. W. GOCHNAUER
Plant Engineer, Northern Paper Mills, Green Bay, Wis.

A PAPER mill in which all the electric power was purchased and high-pressure steam used for heating and process work, installed a 2,000-kw. extraction-type turbo-generator and in about three years saved the cost of the unit with all auxiliary equipment and the expense of changing over 250 motors from 25 to 60 cycles at the time the turbine was installed. During 1925, the turbine operated 7,267 hours and carried an average load of 1,875 kw., making the yearly load factor 80 per cent. Purchased power still supplies part of the load of the mill.

UNTIL the installation of an extraction-type turbine three years ago, high-pressure steam was used for process work and for mill heating during winter months in the plant of the Northern Paper Mills, Green Bay, Wis. This steam was reduced from 150-lb. boiler pressure to 10 to 15 lb. by means of reducing valves located at various points about the mill. At that time there were two spare boilers which were available for additional service, and electric power for the plant was purchased.

The installation of an extraction-type turbine was decided upon in order, first, to utilize the spare boiler capacity, thus increasing the output of the boiler plant and consequently reducing the unit cost of steam produced; second, to act as a reducing valve for supplying low-pressure steam for heating and process work; and, third, for the generation of power for use in the mill when supplying low-pressure steam or when operating as a straight condensing unit.

Such considerations as lower first cost, lighter foundations because of lighter weight, smaller amount of space required and economy of operation, led to the purchase of a turbine rather than a reciprocating engine of equal capacity.

Steam required for the turbine as well as for heating, drying, bleaching, etc., and for driving the variable-speed engines on the paper machines is generated in the boiler plant, in which there are five 3,000-sq.ft. and three 4,000-sq.ft. boilers, all of the Stirling type and stoker fired. Steam is generated at 150 lb. gage without superheat, and the load varies in week days between 175 and 210 per cent of rating.

There is a 175-ft. chimney with an 11-ft. flue. A forced-draft fan maintains a pressure of two to three inches beneath the fire. The draft under the dampers is maintained at one inch with a balanced draft over the fire. On the economizers there are also induced-draft fans.

Approximately 40,000 tons of coal per year is

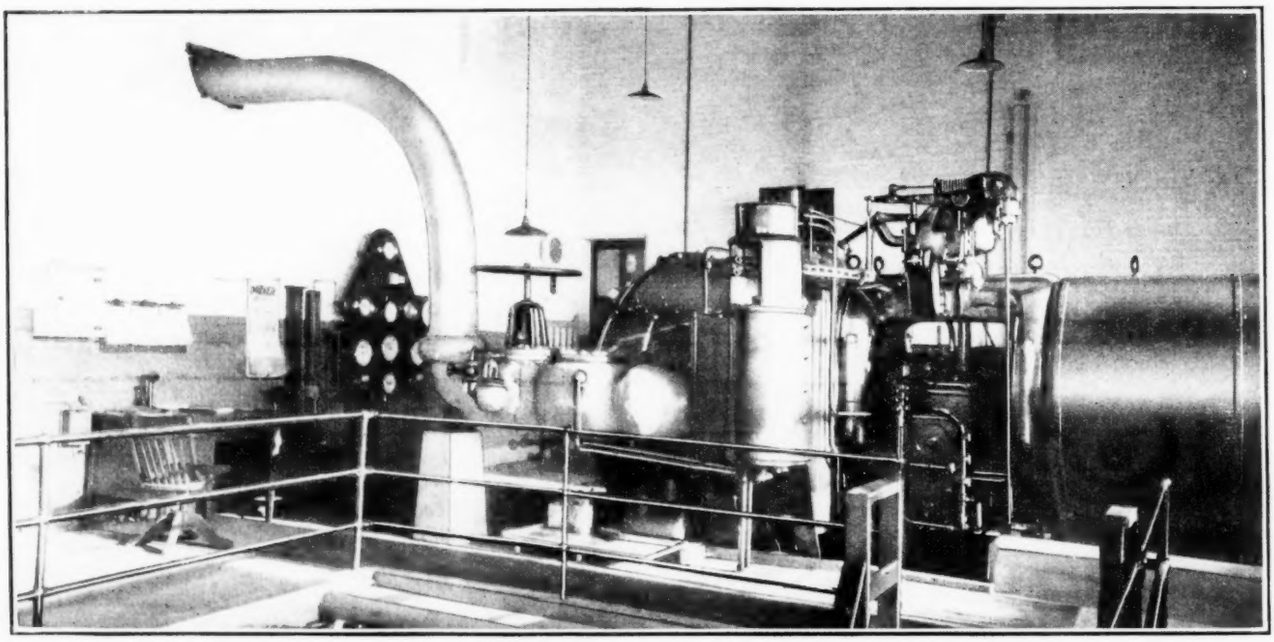


Fig. 1—Turbine operates condensing during the summer months, and low-pressure steam is extracted during the heating season

Fig. 2—Coal is received at the plant's dock by lake boat

unloaded at the plant's dock from lake steamers. From the dock the coal is brought to the boiler house by a system of conveyors which discharge into a bucket elevator. An overhead conveyor delivers the coal to the steel coal bunker, which has a capacity of 120 tons. Coal is delivered to each stoker hopper by means of a traveling weighing larry so that the consumption by each boiler is recorded. During the winter months approximately 150 tons of coal are burned per day, and during the summer, 125 tons. Kentucky Ethel screenings are fired with an average heat value of 13,760 B.t.u. as received, a moisture content of 4.28 per cent and an ash content of 6.24 per cent. One boiler burns wood refuse approximately 12 hours a day.

Each boiler is equipped with indicating, recording and integrating flow meters. Each digester in the sulphite mill and each paper machine is equipped with recording and integrating flow meters. In addition to the meters on each boiler, the boiler room has indicating flow meters for the sulphite mill, paper mill and turbine, and a system of signal lights to show which digester is on, so that the fireman knows at all times just what part of the plant is taking the load. All recording and integrating flow meters, except those for the turbine and paper machines, which are in the turbine room and paper-machine rooms, are located on a master board in a room near the boiler room. On this board are also temperature recorders for flue gas and feed water. A venturi meter measures the feed water.

Five paper machines are driven by variable-speed steam engines ranging in size from 8x10 to 12x14 in. and one by a 150-hp. motor. Pumps, screens, etc., on each machine are driven by individual motors.

The new turbine is a 2,000-kw. 3,600-r.p.m. machine taking steam at 150 lb. gage pressure. The 480-volt 60-cycle three-phase generator is rated at 2,500 kva. and operates at 80 per cent power factor. The power generated is used in the paper mill and sulphite mill for driving various motors. The wood room, and other variable loads are all handled by purchased power. A 2,000-hp. 4,000-volt 225-r.p.m. synchronous motor using purchased power drives two magazine grinders which turn out 25 to 35 tons of pulp a day, depending on the quality required.

The turbine is equipped with a surface condenser with 10,000 sq.ft. of tube surface. Because it has been necessary to use dirty water from the river for cooling, the condenser had to be cleaned every week. During the winter months when the water was cold, the vacuum was 28 in. on Monday when the tubes were clean, but by the end of the week this dropped to as low as 26 in. In the summer, when the water in the river was warm, the vacuum was 27 in. on Monday and dropped to as low as 20 in. by the end of the week. The piping system has been changed recently, so that settled water, which used to go directly to the sulphite mill, can be sent first through the condenser and then to the sulphite mill, which will give cleaner and colder water this summer for the condensers.

During the summer months the turbine is operated straight condensing. The guarantee called for a full-load water rate of 16.5 lb. of steam per kilowatt-hour at 150 lb. gage pressure, with a back pressure of not more than two inches absolute in the exhaust chamber. During April, 1925, the average steam consumption for the entire month was 16.5 lb. per kw.-hr., in spite of the low vacuum obtained toward the end of the week.

During the winter months there is required for heating the mill and for bleaching sulphite more low-pressure steam than can be obtained from the engines driving the paper machines. It is then that the turbine is most valuable. By means of the extraction valve, steam at any desired pressure up to 20 lb. and at any rate up to 20,000 lb. per hour can be taken from the lower-pressure stages after part of its heat has been given up to the turbine. The valve mechanism varies the amount of steam extracted with the amount desired, and maintains it at a predetermined pressure. During January, 1925, an average of 7,424 pounds of steam per hour was extracted.

To determine the cost of electrical energy when operating the turbine straight condensing and when operating it extracting, we have, as shown in Table I, added to the steam cost the average fixed costs including depreciation on the turbine, generator, auxiliaries and building, taxes and insurance, operating labor, repairs and lubrication. These items are based on an average taken over the year 1925. The item of operating labor

includes but one-third the time of the three operating engineers, as the remainder of their time is spent on other equipment.

When the turbine is operating straight condensing,

TABLE I—COST OF PRODUCING ELECTRICAL ENERGY WITH TURBO-GENERATOR
(Average monthly figures, 1925)

Depreciation on turbine generator, auxiliaries and building	$592.33
Insurance and taxes	183.54
Operating labor	167.85
Repairs, lubrication, etc	270.53
Total fixed cost per month	$1,214.25
Fixed cost per hour, $1,214.25 ÷ 605 hr	2.007
Cost per kw.-hr., $2.007 ÷ 2,000 kw.-hr	0.0010
Steam cost, April, 1925, straight condensing, 16.5 lb. at 41c. per 1,000 lb	0.0068
Total cost per kw.-hr., straight condensing $0.0010 + $0.0068	0.0078
Steam cost, Jan. 1925, extracting 7,500 lb. per hr., 15.2 lb. at 35c. per 1,000 lb	0.0053
Total cost per kw.-hr., extracting 7,500 lb. per hr. $0.0010 + $0.0053	0.0063

the cost per kilowatt-hour is but 0.78c., and when 7,500 lb. of steam per hour is being extracted, the cost is 0.63c. Costs for the year 1925 are shown in Table II.

TABLE II—COSTS OF PRODUCING STEAM AND ELECTRICAL ENERGY[1]

Month, 1925	Steam Per 1,000 Lb., Cents	Electrical Energy Per Kw.-Hr., Cents
January	35	0.63
February	36	0.66
March	37	0.64
April	41	0.78
May	40	0.77
June	34	0.68
July	35	0.81
August	36	0.80
September	37	0.85
October	35	0.74
November	34	0.66
December	35	0.64
Average	36	0.72

[1] Variation in cost of steam due primarily to variations in cost of coal.

The turbine generator effected a saving of $54,520 in 1925 over what the cost for purchased power would have been, as indicated in Table III. As compared

TABLE III—SAVINGS EFFECTED BY EXTRACTION-TYPE TURBO-GENERATOR AS COMPARED WITH BUYING POWER AND USING LIVE STEAM FOR HEATING AND BLEACHING

Former cost of steam for heating and bleaching 20,487,400 lb. @ 36c. per 1,000 lb	$7,375.46
Cost of purchased power 13,630,000 kw.-hr. at 1.12c. per kw.-hr.	152,656.00
Total cost per year	$160,031.46
Present cost of heating steam	7,375.46
Cost of generated power, 13,630,000 kw.-hr. at 0.72c. per kw.-hr.	98,136.00
Total cost per year	$105,511.46
Saving per year	$54,520.00

with a straight condensing turbine to carry the electrical load handled by the present unit, and the use of live steam for heating and bleaching, the saving is $9,541 annually, as shown in Table IV. The total sav-

TABLE IV—SAVINGS EFFECTED BY 2,000-KW. EXTRACTION-TYPE TURBO-GENERATOR OVER STRAIGHT CONDENSING TYPE
Cost with straight condensing turbine

Steam required for heating 20,487,400 lb. per year at 36c. per 1,000 lb	$7,375.46
Electrical energy required, 13,630,000 kw.-hr. at 0.79c. per kw.-hr. (averaging running condensing)	107,677.00
Total cost per year	$115,052.46
Present cost per year	105,511.46
Annual saving	$9,541.00

ing due directly to the installation of this unit has exceeded the original cost of the installation, including all foundations, buildings, piping, equipment and the changing of approximately 250 motors from 25 to 60 cycles at the time the turbine was installed. In other words the turbine has saved for the Northern Paper Mills, over the current price of purchased power, better than $100,000 since installation in August, 1922.

Incidentally, the installation of the turbine has practically eliminated shutdowns because of power. Storms and other accidents to the plant or transmission lines of the local public utility made expensive shutdowns in the paper mill not infrequent. At one time three days' operation was lost for such a reason. When a paper mill is down, there is not only a loss of productive time with a consequent increase in overhead per ton of paper produced, but a sudden shutdown may mean a loss of stock or the loss of wires or felts worth hundreds of dollars.

TABLE V—RECORD OF BOILER-ROOM OPERATION

Month, 1925	Pounds Steam Generated	Pounds Steam Per Lb. Coal[1]
January	75,926,000	8.4
February	67,920,000	8.5
March	74,040,000	8.8
April	71,246,000	8.3
May	64,567,000	8.7
June	64,806,000	9.5
July	60,905,200	9.2
August	60,861,700	9.1
September	56,506,000	8.8
October	73,224,000	8.6
November	67,113,600	8.3
December	68,776,100	8.6
Total	805,891,600	
Average	67,157,000	8.7

[1] Obtained by dividing pounds of steam generated by pounds of coal (as received) burned. Average overall efficiency over 70.0 per cent.

TABLE VI—RECORD OF TURBINE OPERATION

Month, 1925	Hours Operated	Total Kw.-Hr. Generated	Steam per Kw.-Hr., Lb.	Steam Extracted	Barometer Inches Mercury	Vacuum, Inches Mercury	Average Load, Kw.
January	624	1,217,928	15.2[1]	4,632,300	29.4	27.2	1,950
February	576	1,146,414	15.7[1]	3,111,200	29.3	27.2	1,990
March	624	1,310,214	15.6[1]	3,509,500	29.4	27.4	2,100
April	624	1,257,124	16.5	.....	29.3	26.9	2,015
May	600	1,156,196	17.2	.....	29.3	27.0	1,928
June	624	1,079,310	18.0	.....	29.3	25.2	1,730
July	586	1,039,518	18.7	.....	29.3	23.9	1,775
August	622	1,029,556	18.3	.....	29.4	25.5	1,655
September	596	991,000	18.0	.....	29.3	25.4	1,660
October	647	1,128,000	17.0[1]	1,777,500	29.3	26.2	1,740
November	576	1,115,000	15.9[1]	3,596,400	29.3	27.1	1,935
December	568	1,160,000	15.8[1]	3,860,400	29.3	27.5	2,040
Total	7,267	13,630,260		20,487,400			
Av. month	605	1,137,521		3,414,000[2]	29.3	26.3	1,875

[1] Water rate when extracting obtained by deducting steam extracted from total steam delivered to turbine, and dividing remainder by kw.-hr. generated.
[2] Average for six months when steam was extracted from the turbine.

AT A MEETING of the Institute of Metals in London on March 10 and 11 there were presented a number of technical papers of interest to the manufacturers and designers of machinery, and particularly to specialists in the properties of metals. The titles follow:

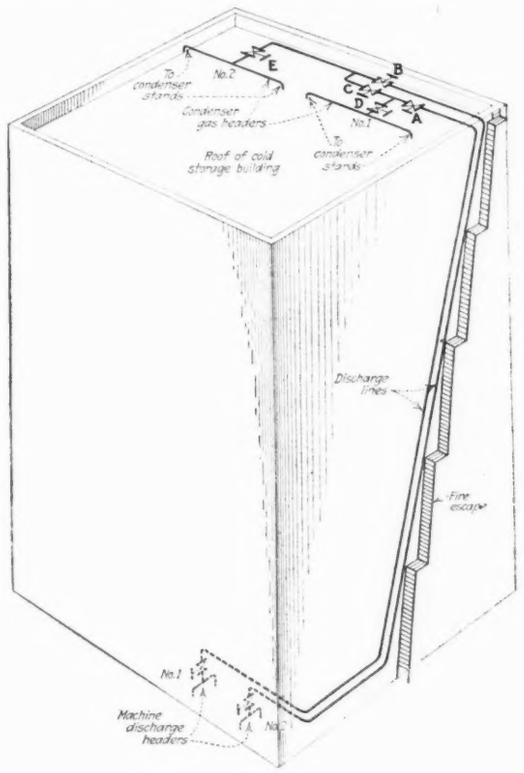
1. Note on the softening of strain-hardened metals and its relation to creep.
2. Note on the corrosion of an ancient tin specimen.
3. Some experiments on the soft soldering of copper.
4. Determination of zinc oxide in brass.
5. Crystal growth in recrystallized cold-worked metals.
6. The interpretation of the macrostructure of cast metals.
7. The hardness of cold-rolled copper.
8. Researches on the nature, properties and conditions of formations of intermetallic compounds, with special reference to certain compounds of tin.
9. The brittle ranges of bronze.
10. The influence of gases on copper at high temperatures, Part I.
11. The die-casting of aluminum alloy—a review of current methods.
12. The constitution of the alloys of silver and tin.
13. Striation due to working or to corrosion in microscopical metallography—a contribution to the study of the etching reagents.
14. The copper-rich aluminum-copper-tin alloys.
15. The mechanical properties at high temperatures of an alloy of nickel and copper, with special reference to creep.

Some Refrigerating Machine Troubles

By CHARLES L. MORGAN

LAST fall the writer had one of the most unusual experiences in the operation of a combination cold-storage and ice-making plant, that will no doubt interest a number of engineers who may run into the same conditions.

The plant had five machines of different capacities, but the two with which this story is concerned were of



Layout of ammonia piping

225-ton capacity each and of the horizontal, double-acting type. They were located on the ground floor of the cold-storage building, with the condensers on the roof, at the opposite end of the building. The schematic layout of the piping system is shown in the accompanying illustration.

In normal operation No. 1 machine operated on No. 1 condenser and No. 2 machine on No. 2 condenser. Cross-connections were provided so that both machines could be run on either one of the two condensers.

Last summer No. 1 condenser developed a number of bad leaks, and as soon as the load dropped off last fall we cut this condenser out, operating both compressors on No. 2 condenser. This was readily done by shutting off valve *D* connecting to No. 1 condenser and opening valve *C* in the cross-connection between the two condensers.

Toward the beginning of December we decided to try to carry the load with only one machine, as the piston rod on No. 2 was pretty bad and it also needed a general overhauling. No. 2 machine was shut down Saturday afternoon. No. 1 compressor handled the load quite well for the first eight or nine hours, and then gradually the frost disappeared from the suction side of the machine; the suction pressure went down, and with it the condenser pressure, while the machine ran hot. The expansion valves and the liquid lines back of them, which normally remain bare and dry, were frosted over up to the point where the insulation covered them.

The night shift experimented with the machine and the system all night without improving matters. The temperature in the brine tank went up continuously, and by the time the day shift came on duty Sunday morning it was about 6 deg. above normal.

The day shift started No. 2 machine immediately, and inside of half an hour the whole system was back to normal. The frost came back to the machines with a rush, and they had to do some speedy work on the expansion valves to prevent flooding the machines. The brine temperature came down in a hurry, and toward evening they could hold the temperatures with both machines running at less than half speed.

During the middle of the week the load dropped off considerably, and the chief engineer decided to try cutting out No. 2 machine again; toward evening the same symptoms appeared that have been previously described. A hiss or whistle could be heard, apparently as if gas instead of liquid was passing through them. The same sound could be heard in the liquid receiver, as if it was empty and high-pressure air was passing through it. About an hour before going off duty, the chief ordered No. 2 machine cut in again, and the same thing happened that had happened in the previous case. Everything came back to normal inside of half an hour.

While we were experimenting with the machine next day, the stuffing box of No. 1 compressor got hot and became so tight that it almost stopped the machine. The chief decided to shut it down and repack.

To everybody's surprise No. 2 compressor started away without trouble and operated perfectly normal for the rest of the day and the following night, carrying the load with reduced speed.

Several other attempts were made to handle the load with No. 1 machine, with practically the same results. Some days it went along fairly well, and the trouble would develop during the night. At other times the trouble was just as prominent during the day run as at night. No one was able to give a reasonable explanation of the cause of the trouble, and from all indications the liquid ammonia disappeared somewhere, the charge ran short, and the trouble began.

One day a gasket in the gas line to No. 2 condenser blew out and the condenser had to be shut down. The load was switched over to No. 1 condenser, which fortunately, had not been opened up for repairs. At about the same time the dashpot on the steam engine of No. 2 machine jammed for some reason, and the machine was shut down for the day. While it was down the chief also wanted to have a look at one of the valves, so the discharge line was pumped down and the machine opened up.

We all expected that our usual trouble would show up again after a few hours, but No. 1 held the temperatures without trouble and at less than full speed, all day and all night. As a matter of fact it did better than No. 2 in handling the load. By this time the action of the two machines was beginning to be quite a joke and everybody was taking turns in offering a solution of the puzzle.

A couple of days later the oiler noticed a bad leak in the flange on the stop valve at the header of No. 2 compressor. In order to insert a new gasket the discharge line of No. 2 compressor had to be pumped down. I opened the bypass valve between the suction header and the discharge line, and also the other bypass connection between discharge header and suction line.

Something else turned up at this moment that required attention. When this had been attended to, I went to open the bypass on the discharge-line check valve, which was just inside the engine-room wall.

I was much surprised to note that a frost line had appeared on the check valve. I called the chief's attention to this new development, and he could think of no satisfactory explanation for it. In the meantime I started to open the bypass valve on the check valve.

As soon as I started to open this valve, a sharp frost line appeared across it; also the discharge line between the check valve and the compressor began to frost. After a while the whole section of the discharge line between the check valve and the compressor discharge header, and the machine became frosted, indicating that there must be liquid evaporating in the line, as by no other analysis could we account for this development.

I do not remember now just how long it took for this liquid to work through, but I believe it took the best part of two hours before the frost finally came off the discharge line, indicating that the liquid was out. When this finally took place, I opened the bypass on the check valve wide and started to pump down.

I had one of the men keep the machine working slowly while I went up on the roof to investigate matters. Valve *B* was shut tight, but I could plainly hear gas leaking through. Something was plainly wrong with this valve.

In order to get at this valve we had to switch condensers once more, No. 1 compressor carrying the load on No. 1 condenser. Condenser No. 2 was pumped down, valves *E* and *C* were shut and once more we started to pump down, with valve *B* open. This time the pressure came to a vacuum in a hurry and remained there. The bonnet was then removed from valve *B* and the disk was taken out.

The disk was of the babbitted type. Part of the babbitt lining of the disk had cracked and fallen out, leaving quite an opening in the valve even when it was shut.

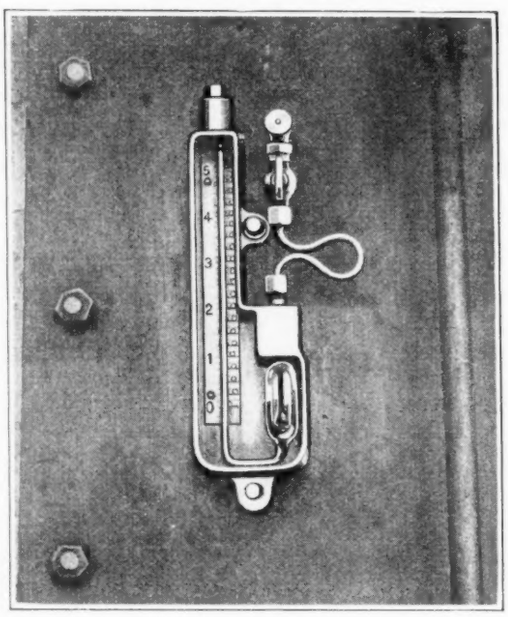
The greater part of the day was gone before we finally got the line closed up again and tested. Valve *B* was first tested by opening up valve *C* in the cross-connection on top of the roof; this showed it to be absolutely tight, after which the line was tested down to the discharge stop valve and *B* was again shut off. Condenser No. 2 was again cut in, condenser No. 1 was cut out and pumped down, because the leaks were now more pronounced than ever, and the whole system was once more back to the same method of operation that had continuously caused us trouble before.

From all indications, when No. 1 machine was operated alone during the trouble, the ammonia charge became pocketed somewhere. The only rational explanation we can think of is that with valve *B* leaking, full condenser pressure was carried in the discharge line of No. 2 machine, down to the check valve, all the time, even with the machine shut down. The discharge lines, as before stated, were on the north side of the building. The outside temperature during this period went down to nearly zero on several occasions and most of the time was below freezing. As a consequence the long discharge line acted as a condenser, the liquid accumulated in the line down to the check valve. This will account for the frost at the check valve when I opened the bypasses on the machine, as the check evidently was not absolutely tight; it also accounted for the frosting of the discharge line when the discharge check valve bypass was opened.

The line was 5 in. in diameter and about 300 ft. long. The system was probably rather short of ammonia to start with, and with this 5-in. line possibly filled for its entire length with liquid, there was not enough left to operate the system properly.

Combustion Control

A novel method of regulating the draft under oil fuel boilers has been put into use at the plant of the Savannah Electric Co., Savannah, Ga. The plant burns oil, mechanical atomizers being used. To obtain satisfactory combustion with oil, it is of course necessary to have the oil and air proportions correct. The quantity of oil to the burners depends upon the pressure in the oil line, and the oil-pump speed is regulated to meet the load conditions.



Regulating draft with oil burning

Tests were run to determine the amount of draft necessary at various loads, and the oil pressures at these outputs were noted. A draft gage, shown in the illustration, was modified by having an oil-pressure scale placed alongside the draft scale.

In operation the fireman controls the oil pressure to meet the load used, then adjusts the draft so that the reading on the draft scale corresponds to the oil pressure.

Operation of the Enco Automatic Combustion Control System

COMBUSTION is the chemical process of combining the carbon in fuel with oxygen in air, for producing heat. This is done most economically when supplying a given quantity of air for a given quantity of fuel. Unless the correct proportions are maintained, which will vary somewhat with conditions, the efficiency of the combustion process may vary through wide ranges. Owing to improper proportioning of the air and fuel and to other causes, it is estimated that the average boiler efficiency is about 56 per cent, when it should be between 70 and 80 per cent. Modern boiler-plant equipments have operated at over 90 per cent efficiency.

If the steam pressure is to remain constant, heat must be supplied to the boiler at the same rate that it is taken out, which means for any quantity of steam that is taken out a quantity of fuel and air must be consumed in the furnace to supply an equivalent amount of heat to the boiler. To maintain the fuel bed in the furnace of a stoker-fired boiler, a quantity of fuel must be put on the grates equal to that burned. Although this fuel is not burned when first put on the grates, it is being put into readiness when required at some time later. When gas or similar fuels are burned, the fuel entering the furnace with the air is immediately consumed, but the process is very much the same as for stoker firing, in that for all the heat taken out of the boiler, a quantity of fuel and air must be put into the furnace that will supply an equivalent amount of heat to the boiler.

Supplying fuel and air to the boiler in proper proportions are only two of the important functions in combustion. The third is removing the gases from the furnace. This should be accomplished by maintaining sufficient differentials of pressure across the boiler to cause the gases to flow to the stack, and at the same time keep a pressure over the fire best suited to the operating conditions. This pressure is generally slightly less than atmosphere.

To maintain by hand the correct relation between fuel and air supply and the removal of gases is obviously almost physically impossible, so that automatic combustion control becomes desirable. This fact is more generally recognized now than ever before, and few important stations are designed today in which a system of automatic combustion control is not considered.

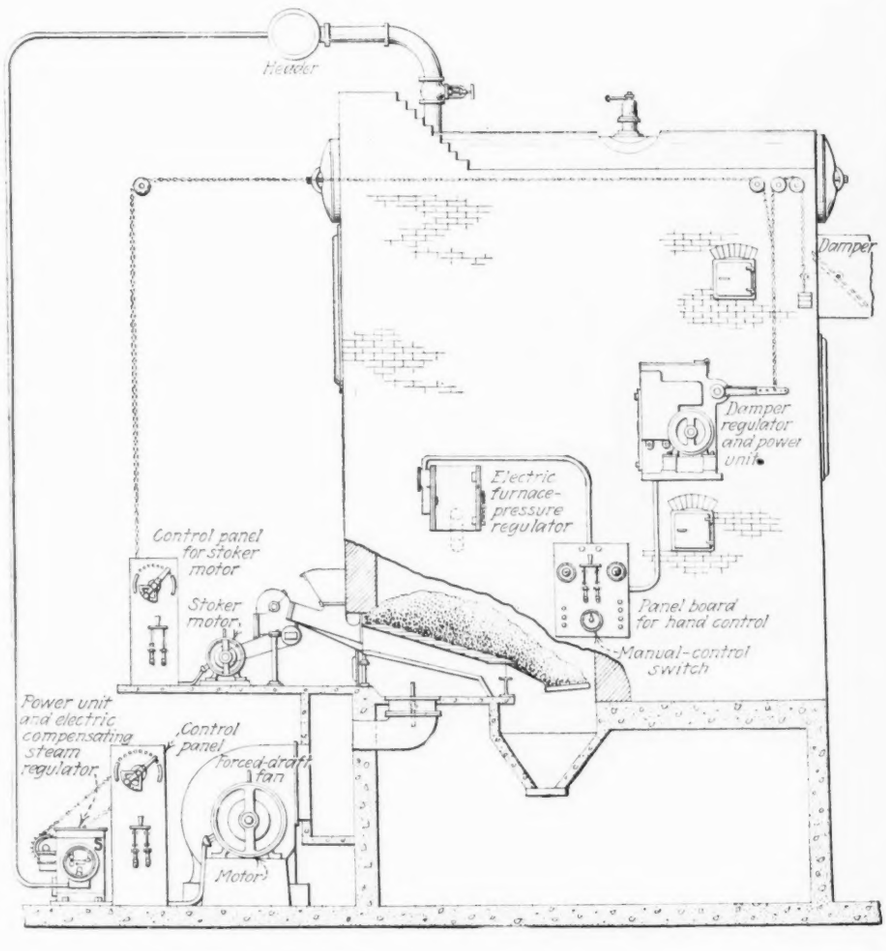


Fig. 1 (Left) — Diagram showing general arrangement of the combustion-control equipment applied to one stoker-fired boiler

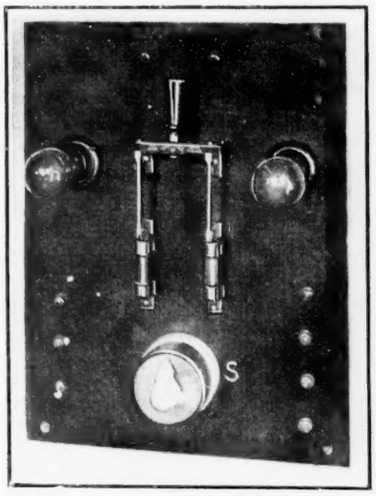


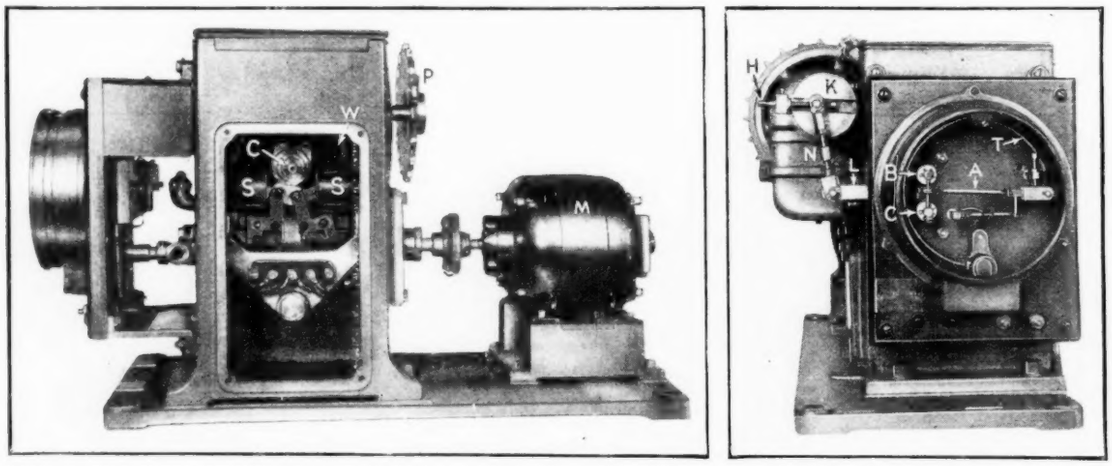
Fig. 2 (Above) — Panel board for switching from automatic to hand control of damper and stoker. Switch S has four positions; damper open, damper closed, on automatic control and off

The Engineer Company, New York City, has developed and placed on the market an electrical system of combustion control based on its well-known system of "Balanced Draft." In this, which is known as the "Enco Electric Combustion Control," the initial impulse is a variation in steam pressure. As long as heat is being put into the boiler as fast as it is being taken out, the pressure will be constant. When the rate of taking heat out increases above the in-going rate, a deficiency results and the steam pressure drops. On the other hand, if the rate of taking heat out of the boiler drops below the rate of putting it in, an excess will accumulate and the steam pressure will rise. The whole process of boiler operation may be reduced to terms of maintaining the steam pressure constant and doing this with a minimum fuel consumption, consistent with other conditions.

This system, as applied to a forced-draft stoker-fired boiler, is shown diagrammatically in Fig. 1. A variation in steam pressure is transmitted to the electric-compensating regulating switch *S* on the power unit at the forced-draft fan. Assume an increase in the demand for steam. This will cause a decrease in pressure, and the regulator switch will close one of its two contacts and energize the power unit. Energizing the power unit causes it to function and increase the speed of the forced-draft fan to supply more air to the furnace and accelerate the rate of combustion to meet the demand for more heat in the boiler.

The contacts on the steam regulator are arranged to float and are attached to the power unit so that when the fan has been speeded up a given amount, the regulating switch contact is opened and the speeding-up process stops. If this is not sufficient to supply the increased demand for steam and the pressure continues to decrease, the contact on the regulating switch will again close and energize the power unit and cause a further increase in the speed of the fan, which is again stopped by the power unit opening the contact on the regulating switch. From the foregoing it is seen that for each incremental decrease in steam pressure the forced-draft fan is caused to increase in speed a given amount, and when this change is accomplished the speed remains constant until there is another change in pressure, so that the change in rates of combustion is made in definite steps.

With the first increment change in the forced-draft fan's speed, the pressure is increased in the furnace and operates the electric furnace-pressure regulator, causing it to close one of its two contacts. This energizes the power unit on the damper regulator and causes it to start opening the damper and increasing the speed of the stoker. Opening the damper increases the suction through the boiler and decreases the furnace pressure. As soon as the damper reaches a position where the furnace pressure has returned to normal, the electric furnace-pressure regulator returns to normal position and opens its contact so that further movement of the power unit and damper and change in stoker speed is stopped. If there is a second incremental decrease in steam pressure as previously explained, then there will result a second movement of the electric furnace-pressure regulator, which in turn will cause a further opening of the damper and increase in the speed of the stoker to correspond to the increase in the fan's speed. On taking load off the boiler the pressure increases and the reverse of the previously described operations takes place and slows down the combustion process.



Figs. 3 and 4—Two views of the power unit and electric compensating steam regulator

The panel board shown in Figs. 1 and 2 provides a means for switching the damper control from hand to automatic and for controlling the damper's position and stoker's speed independently of the operation of the rest of the equipment. In case the boiler operator wishes to blow the soot off the tubes, he can throw the manual control switch to the damper-open position and the power unit will move the damper to the full-open position. The damper may be stopped in any position at the will of the operator. When the damper is again switched to automatic control, the power unit will bring it to the position to give a pressure in the furnace corresponding to that for which the electric furnace-pressure regulator is adjusted.

The base machine for this system is what is known as the power unit. This unit is the same for all uses, whether for adjusting fan speed, fuel speed or damper position. Starting, stopping and reversal of this unit are accomplished by different devices, depending upon the regulating functions.

The power unit, two views of which are shown in Figs. 3 and 4, comprises a double-worm transmission running in oil. One of these worms is connected to the driving motor *M* and the other to the sprocket wheel *P*,

which may be used to attach the unit to a rheostat, damper or other device. Instead of a sprocket wheel a lever attachment may be used if desired. The incoming and outgoing worm gears are connected by a ratchet mechanism having two wheels with the teeth in one wheel set opposite to those in the other. One of the wheels can be seen at *W* and a pawl is provided for

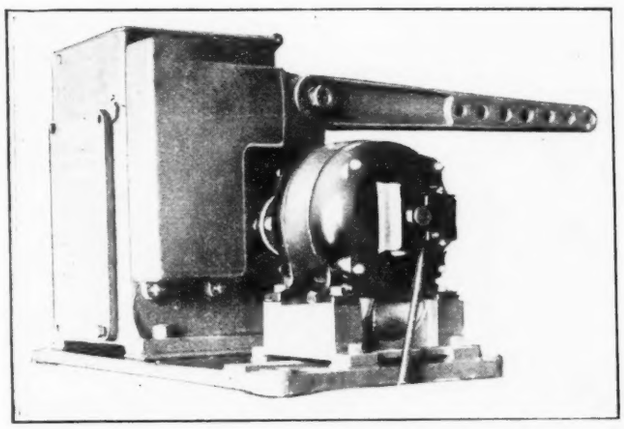


Fig. 5—Power unit with control-lever connection

operating each wheel. The pawls are carried on the upper end of an arm that oscillates about the center *C*, this arm being driven by the motor. As long as the machine is running idle, the pawls are prevented from engaging the ratchet wheels by a retainer that oscillates with the pawls.

This pawl retainer is mounted on the upper end of an arm the lower end of which is attached to the cores of the two solenoids *S*. As long as these coils are dead, the cores are free to oscillate in and out of the coils as the pawl retainer arm is oscillated by the pawl arm. When one of the solenoid coils is energized, it holds its core from moving out and in doing so holds the pawl retainer in a position to let one of the pawls engage its wheel and move it as the pawl continues to oscillate. The pawl moving its wheel transmits motion to the device to which the unit is connected.

In Fig. 4 is shown a compensating steam regulator switch mounted on the power unit. The Bourdon tube *T* is connected to the steam header and to contact arm *A*. A change in steam pressure will cause the left-hand end of arm *A* to move up or down in contact with either *B* or *C*. When arm *A* makes contact with either *B* or *C*, it energizes one of the solenoids *S*, Fig. 3, which in turn holds its core and allows the unit to turn the sprocket wheel and whatever may be attached to it.

On the opposite end of the sprocket-wheel shaft is an adjustable crank *K*, which is attached to lever *L* by link *N*. Contacts *B* and *C* are mounted on lever *L* and are free to move with it. After arm *A* has made contact with, say, contact point *B* and energized the power unit and caused it to start turning the sprocket-wheel shaft, it will move crank *K* and lever *L* in a direction to carry contact *B* upward away from arm *A*, breaking the circuit to the solenoid and de-energizing the power unit, thus stopping further change in speed of the combustion equipment, as previously explained. In this way the speeding up or slowing down of the combustion process is made in steps.

For example, assume that the steam pressure drops one-half pound and arm *A* makes contact with *B*. This will cause movement of the power unit to speed up the combustion process, but this is stopped after a short interval by *B* breaking contact with arm *A*. If this speeding up of the combustion process has not been sufficient to meet the demands for steam and the steam pressure continues to fall, arm *A* will again make contact with *B* and another impulse will be sent out through the system to increase further the speed of the combustion equipment. With rising steam pressure the combustion process is slowed down in steps by arm *A* making contact with *C*. Crank *K* is made adjustable so that the connection for the upper end of link *N* may be shifted and in this way the time that arm *A* will remain in contact with *B* or *C* can be varied. The farther the upper end of link *L* is away from the center of the disk, the shorter the period will be that the contacts remained closed on the pressure switch. The compensating connection is so made that by adjustment of a hand screw *H* a wide range of compensation may be secured. Successive steps of movements are secured by changes in steam pressure of about ¼ lb. This compensation can be adjusted so that the development of the plant's capacity from minimum to maximum may be spread over a 25-lb. change in steam pressure, or adjusted to a range of only one pound, depending on how closely it is desired to maintain the standard steam pressure.

The power unit is driven by a standard constant-speed ½-hp. motor running continuously in one direction. The motor may be either direct-current or alternating-current type and for any standard voltage. Each power unit has mechanical limit stops to prevent overtravel,

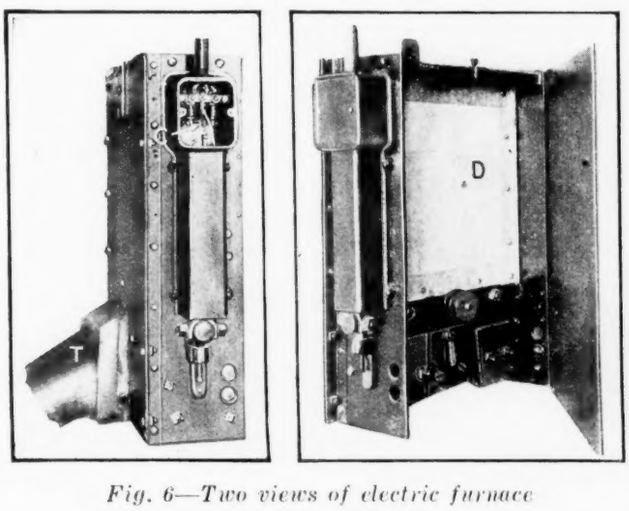


Fig. 6—Two views of electric furnace pressure regulator

and the unit is capable of varying speed ratios between advance and reverse of 1 to 1, 1 to 2, 1 to 3 and 2 to 3. For example, the power unit can be adjusted to open the damper at the same rate that it is closed, or open twice or three times as fast as it closes.

The arrangement of power unit and pressure switch as shown in Figs. 3 and 4, is that ordinarily used for operating a forced-draft fan. With the pressure switch removed, the unit could be used for operating a damper or for controlling the speed of an induced-draft fan. In either of these two applications, the solenoids on the

unit would be energized by contacts on the electric furnace-pressure regulator. Instead of using a sprocket wheel and chain to operate the control equipment, a lever may be attached to the power unit as in Fig. 5 and this connected to the damper or to the control rheostat on a fan or stoker motor.

When the power unit is used to control furnace pressure, by damper control or adjustment of the induced-draft fan speed, its operation is controlled by the electric furnace-pressure regulator, Fig. 6. This regulator is a swinging blade diaphragm *D* balanced on a knife-edge in a box in the furnace wall. The space in the box back of the blade is connected to the furnace through a draft tube *T*. Any tendency of the diaphragm to swing due to a difference between furnace pressure and atmosphere is opposed by springs. On the shaft of the swinging diaphragm is a contact rod operating between two contacts located at *C*. As the changes in furnace pressure become greater or less than the setting of the draft springs, the blade moves and closes one of its electric contacts to complete the circuit for a corresponding solenoid on the power unit, which is put into operation to restore the furnace pressure to normal. When this has been done, the diaphragm comes to the neutral position and adjustment of the draft equipment by the power unit stops.

Where a number of units are to be controlled from a central point by a master control, electric sending and receiving units are used, shown in Figs. 7 and 8. The electric sender or the receiver may be attached to any power unit irrespective of the apparatus controlled, which may be on steam pressure, fuel feed, or

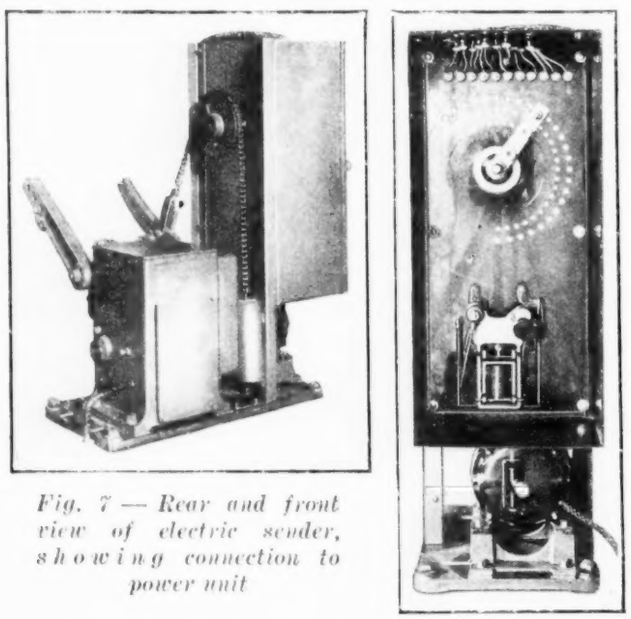


Fig. 7 — Rear and front view of electric sender, showing connection to power unit

damper movement. Assume a pulverized-coal installation. One electric sender, receiving its initial impulse from an electric pressure switch would be used. An electric receiver would be placed on the fuel feed, primary air supply and secondary air supply; the stack-draft equipment being an independent unit to maintain constant draft.

The electric sending unit, Fig. 7, is a dial switch driven in any convenient way from a power unit. The contact points on the dial switch are connected by wires to the receiving unit. When the sending unit is controlled by steam pressure, as the pressure changes a contact is closed in the pressure-regulating switch as explained in Figs. 3 and 4, and energizes the power unit. The power unit then moves the arm on the dial switch one point, when it is stopped by the compensation opening the contact on the pressure switch. Making the contact on the dial switch energizes a circuit

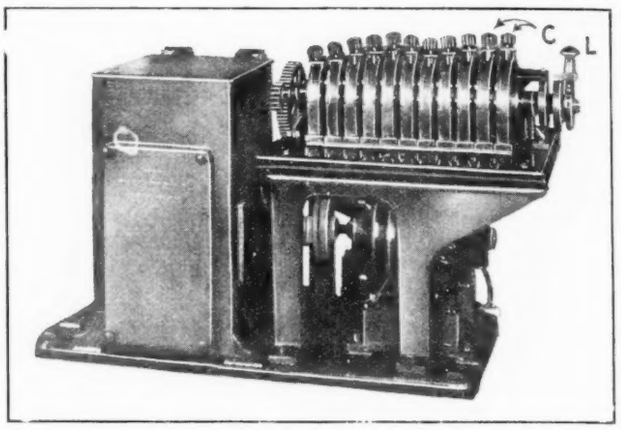


Fig. 8—Electric receiver connected to power unit

to each of the power units on the electric-receiving units. This causes each receiving unit to respond to the sending unit.

The receiving unit, Fig. 8, consists of a metal cylinder divided in two parts spirally by strips of insulation and driven by a power unit. One half of this cylinder is connected electrically to the advance and the other to the reverse solenoids of the power unit. Riding on the surface of this cylinder are a number of adjustable contacts *C*, one for each wire from the sending unit. These contacts are adjustable circumferentially at right angles to the axis of the cylinder, so that the receiving unit can be made to vary the characteristic of the device it is controlling through a wide range and all receiving units may be adjusted differentially. The position of the cylinder on its shaft can be adjusted by lever *L*, which is equivalent to group adjustment without disturbing the original calibration.

As previously explained, by means of the electric sender a contact on the dial switch is energized, which sends a current through a given wire to a corresponding contact on the cylinder of the receiving units. This contact will be on either one side or the other of the insulated strip between the two halves of the cylinder, therefore completes the circuit to one of the solenoids on the power unit. Energizing the solenoid will start the power unit in motion and effect a regulation of the combustion apparatus to which it is attached. At the same time the movement of the power unit turns the contact cylinder and the apparatus will keep in motion until the insulation strip moves under the contact, through which the circuit was completed, at which time the movement stops. This action will be repeated if the first movement is not sufficient, and the receiver will cause its power unit to advance or reverse according to the contacts energized on the sending unit.

The equipment allows for almost unlimited combinations. Any part of the combustion process may be controlled automatically, each boiler can be controlled as a unit, or a number of boilers can be controlled as a group automatically from a master switch.

Rates of Starting and Stopping Elevators and Their Effect on Service

BY HOWARD B. COOK
Electrical Engineer, The Warner Elevator Manufacturing Company, Cincinnati, Ohio

RATES of acceleration and retardation of elevators are of interest not only to elevator engineers, but also to operating engineers. In the first case they are a factor in determining what may be expected of a given elevator and with the latter they can be used as a check to determine if the operators are getting out of the elevator equipment what it is capable of doing. In this article the author has succeeded in presenting the subject in an easily understood manner.

AN IMPORTANT factor in elevator service is the distance or the time required to attain full speed or to stop from full speed. This factor has not been given the consideration it deserves because of the difficulties experienced in measuring the various quantities involved and also because of the fact that its importance is not widely appreciated.

Many words such as "pep," "getaway" and "pickup" have been used to express the ability of a mechanism to attain full speed quickly, but the word "acceleration" is really more expressive and more definite than the other expressions.

It is not sufficient to know that one type of elevator equipment will accelerate more rapidly than another. Such qualitative knowledge is of little value, and unless quantitative knowledge can be obtained that will make a direct comparison possible, the real value of this factor cannot be determined.

Acceleration can be defined as the rate of change of velocity, and actual values can be found that will make possible the determination of the time-saving possibilities of high rates. Moreover, it is not necessary to resort to involved mathematics to obtain a definite conception of acceleration. The following illustrations will serve to introduce acceleration to those who are not familiar with it:

If a person walks a mile the first hour, two miles the second hour, three miles the third hour and four miles the fourth hour, the rate of acceleration will be one mile per hour per hour, that is, the rate of increase in speed.

If an express train attains, from rest, a velocity of sixty miles per hour after an elapsed time of thirty seconds, then the average rate of acceleration is two miles per hour per second. This is the form of expression that is generally used to designate the rate of acceleration in railway service. Sixty miles per hour is equivalent to 88 ft. per sec., and two miles per hour per second is equivalent to approximately three feet per second per second.

If an elevator attains a speed of 60 ft. per min. at the end of the first second, 120 ft. per min. at the end of the second second, 180 ft. per min. at the end of the third second and 240 ft. per min. at the end of the fourth second, the rate of acceleration is 60 ft. per min. per sec. This is the same as a rate of acceleration of one foot per second per second.

Acceleration, or change in velocity, is the result of a force acting against weight. If the weight is small and the force large, the acceleration will be high. A force of one pound acting against a weight of one pound will produce a rate of acceleration of 32.16 ft. per sec. per sec. This is gravity acceleration and can be expressed by saying that a free falling body increases its velocity 32.16 ft. per sec. for every second that it falls.

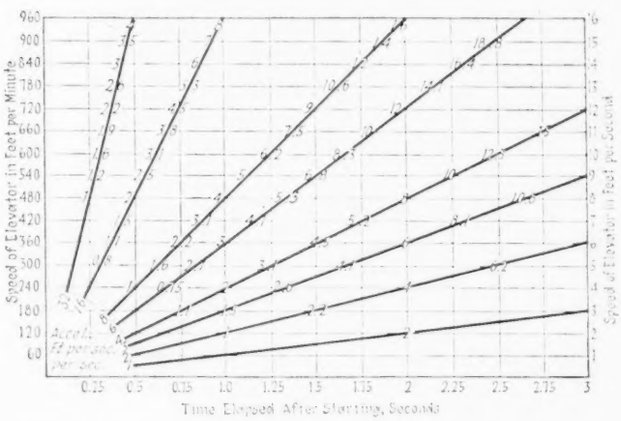


Fig. 1—Curves showing time required by an elevator to attain different speeds

Figures on the curves indicate the space passed through in feet. For example, with 4 ft. per sec. per sec. acceleration, the elevator will attain a speed of 600 ft. per min. in 2.5 sec. and will travel 12.5 feet.

The curves, Fig. 1, show the velocities attained by an elevator at various rates of acceleration. The figures on the curves give the distances passed over in feet. For instance, at 4 ft. per sec. per sec. acceleration, the elevator will attain a speed of 600 ft. per min. in 2.5 sec., and will have traveled 12.5 feet.

The final velocity attained, is found by multiplying the rate of acceleration by the time. In Fig. 1 the elevator attains a speed of 10 ft. per sec. in 2.5 sec. when accelerated at a rate of 4 ft. per sec., or the speed attained is equal to $4 \times 2.5 = 10$ ft. per sec. (600 ft. per min.). The average velocity is equal to one-half of the maximum velocity and the distance passed over is obtained by multiplying the elapsed time by one-half of the final velocity.

Stopping is negative acceleration and is called retardation. The rate of retardation of an elevator is not usually the same as the rate of acceleration, but, as will be shown later, the average of both can be used for the purpose of classifying elevators. A high rate of retardation is just as important as a high rate of ac-

celeration. A low rate of acceleration will negative the effect of a high rate of retardation and vice versa.

If the torque of the elevator motor were constant and if the friction were constant, the rate of acceleration would be constant. Neither of these factors is constant, however, and it is almost impossible to calculate their instantaneous values.

From the viewpoint of service it is not necessary that the rate of acceleration be constant, although from the viewpoint of comfort it is desirable that rapid changes of speed be eliminated so that jerks will not be felt by the passengers.

The average rates of acceleration and retardation actually encountered in elevator service vary from two to six feet per second per second. The higher-speed elevators will usually have the higher rates, but this is not always true.

The curves in Fig. 2 are space-time curves plotted from the results of calculations made to determine the time required by an elevator to travel various distances with different speeds and rates of acceleration and retardation. The rate of acceleration is assumed to be equal to the rate of retardation in each case. Curves have been drawn showing the time required to travel distances of 10, 20 and 30 ft. at speeds of 300, 450 and 600 ft. per min. with rates of acceleration of 2, 4 and 6 ft. per sec. per sec. These curves show the time-saving effect of rapid acceleration.

For instance, an elevator having a normal speed of 300 ft. per min., curve *A*, with a rate of acceleration of 2 ft. per sec. per sec., will travel a distance of 10 ft., including starting and stopping, in 4.4 sec., whereas, if the rate of acceleration were 6 ft., curve *B*, the time would be 2.83 seconds.

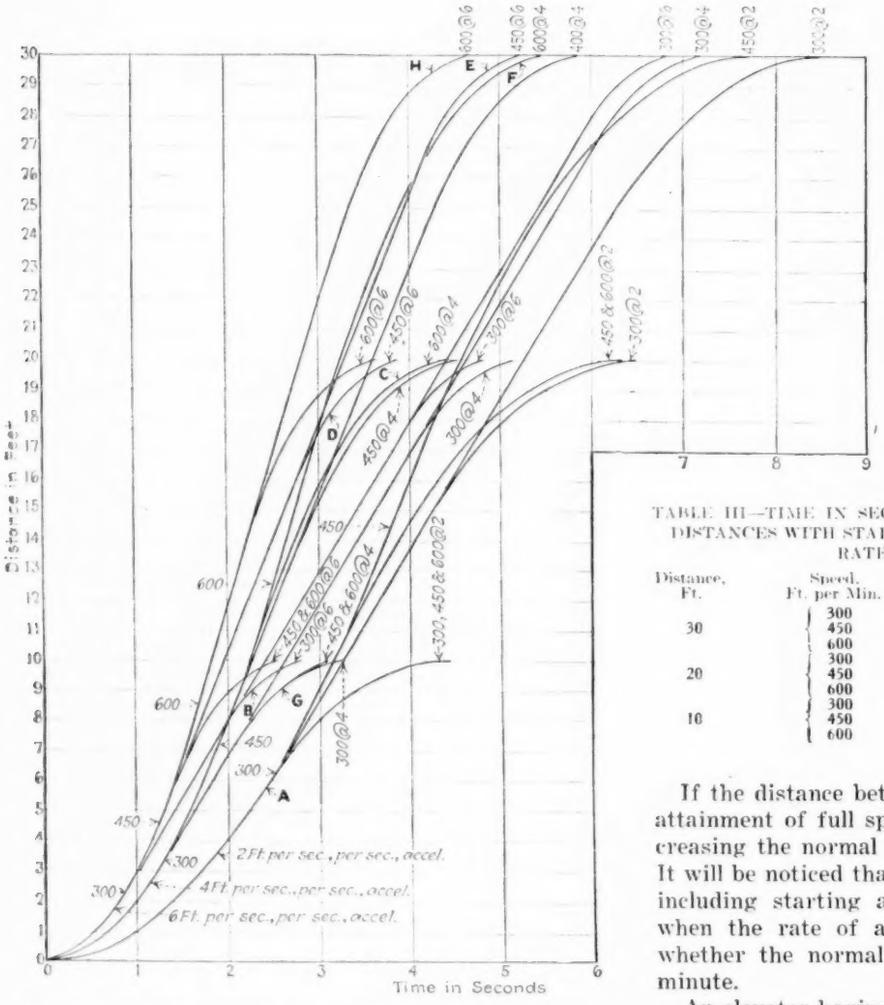


Fig. 2—Curves showing time required to travel various distances, including starting and stopping, at various speeds and rates of acceleration

TABLE I—DISTANCE IN FEET REQUIRED TO ATTAIN VARIOUS SPEEDS AT DIFFERENT RATES OF ACCELERATION

Speed, Ft. per Min.	Rate of Acc. Ft. per Sec. per Sec. 2	4	6
300	6.25	3.125	2.083
450	14.1	7.1	4.7
600	25.	12.5	8.33

TABLE II—TIME IN SECONDS REQUIRED TO ATTAIN VARIOUS SPEEDS AT DIFFERENT RATES OF ACCELERATION

Speed, Ft. per Min.	Rate of Acc. Ft. per Sec. per Sec. 2	4	6
300	2.5	1.25	0.83
450	3.75	1.88	1.25
600	5.	2.5	1.67

TABLE III—TIME IN SECONDS REQUIRED TO TRAVEL VARIOUS DISTANCES WITH START AND STOP AT VARIOUS SPEEDS AND RATES OF ACCELERATION

Distance, Ft.	Speed, Ft. per Min.	Rate of Acc. Ft. per Sec. per Sec. 2	4	6
30	300	8.5	7.25	6.83
	450	7.74	5.86	5.25
	600	7.74	5.5	4.67
20	300	6.5	5.25	4.83
	450	6.32	4.54	3.91
	600	6.32	4.46	3.67
10	300	4.4	3.25	2.83
	450	4.4	3.16	2.58
	600	4.4	3.16	2.58

If the distance between stops is not sufficient for the attainment of full speed, no advantage is gained by increasing the normal speed above that actually attained. It will be noticed that the time required to travel 10 ft., including starting and stopping, curve *A*, is 4.4 sec. when the rate of acceleration is 2 ft., regardless of whether the normal speed is 300, 450 or 600 ft. per minute.

An elevator having a normal speed of 600 ft. per min. with a rate of acceleration of 4 ft. per sec. per sec., curve *C*, will travel a distance of 20 ft., including starting and stopping in 4.46 sec., while an elevator having a normal speed of 450 ft. per min. with a rate of acceleration of 6 ft. will travel the same distance in 3.91 sec., curve *D*. Even for a distance of 30 ft. the 450-ft. per min. elevator would still have a slight advantage, curves *E* and *F*.

Attempts have been made to calculate the rate of acceleration of an elevator, but the necessary assumptions render the results of doubtful value. A spring scale with a weight can be used to determine the rate of acceleration. If a spring balance were suspended in an elevator car and if a weight were suspended from the hook, the true weight would be shown only while the car is at rest or moving at a constant speed. If the car should start to fall freely, the tension on the spring of the scale would be reduced to zero, and any person

standing in the car would cease to impose any weight on the floor. This is gravity acceleration.

A rate of acceleration of 4 ft. per sec. per sec. would be one-eighth of gravity acceleration, and the weight suspended from the spring balance would be increased or decreased by one-eighth of the weight as measured at rest, depending upon whether the acceleration occurred while the car was ascending or descending. All masses in the car are affected in the same manner; in

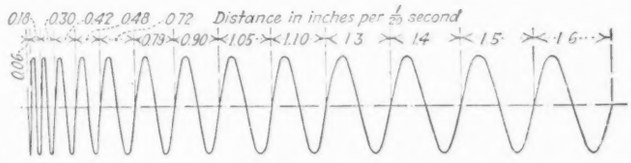


Fig. 3—Test curve from which rates of acceleration and retardation are determined

fact, the tension in the lifting cables is increased when the car starts to ascend.

Most people think that it is the speed of an elevator that causes the discomfort felt when the car is started and stopped. Speed does not cause discomfort in vertical travel any more than it does in horizontal motion. We ride on an express train at a speed of 60 miles per hour and cannot determine the direction of motion unless we can look out of the window and see the passing scenery. It is the force of acceleration or retardation that causes discomfort, and it ceases just as completely when the car attains full speed as when the car is standing still. If the rate of acceleration is high, the effect on the passengers is more intense, and if the speed is high, the effect persists longer, because more time and distance are required to attain full speed or to stop from full speed.

Attempts have been made to draw velocity curves by means of electrical and mechanical tachometers, but these instruments are too sluggish for accurate results. It would be possible to take moving pictures of the car with a known time interval between the exposures. From these pictures the distance traveled by the car in a given time interval could be determined and the instantaneous velocities could thus be calculated.

A method is available by which accurate results can be obtained in a simple manner. This method is used in physics laboratories for obtaining the acceleration of falling bodies and by the ordnance department for determining the acceleration of gun recoil.

If a paper tape is attached to the periphery of the driving sheave of an elevator winding engine and if a pencil is oscillated across the face of the tape, then when the elevator is started a wavy line will be drawn on the tape, Fig. 3. The distance from one wave to the next is the distance that the elevator travels during one oscillation of the pencil. From these results the instantaneous velocities can be plotted.

Fig. 4 shows velocity curves for a 500-ft. per min. elevator that were obtained in this manner. The pencil in this case oscillated at the rate of 1,200 complete oscillations per minute, or 20 per second. The velocities were obtained for each twentieth of a second and the results are very accurate. The steepness of the slope of these velocity curves determines the rate of acceleration.

It will be noticed that the retardation curves, Fig. 4, have a horizontal portion. This indicates that the elevator was slowed down to an intermediate speed before the stop was made. With full load descending, it will be observed that the car attained a velocity of 5 ft. per sec. at the end of the first second, and with full load ascending, a velocity of 3 ft. per sec. was attained. The rates of acceleration were therefore 5 ft. and 3 ft. per sec. per sec. respectively. It will also be noted that these rates were not maintained to full speed, but reduced as full speed was approached. This is indicated by the drooping of the curves.

The winding engine of this elevator was of the single-worm-gear type, driven by a direct-current motor with a ratio of three to one, by shunt-field control. Rheostatic control was used for the motor, and the operation of the accelerating magnet was governed by counter-electromotive force which has practically the same characteristics as current-limit control.

Each different type of elevator equipment would show different characteristics in the acceleration curves. It is possible to determine the approximate average of the rates of acceleration and retardation by means of a

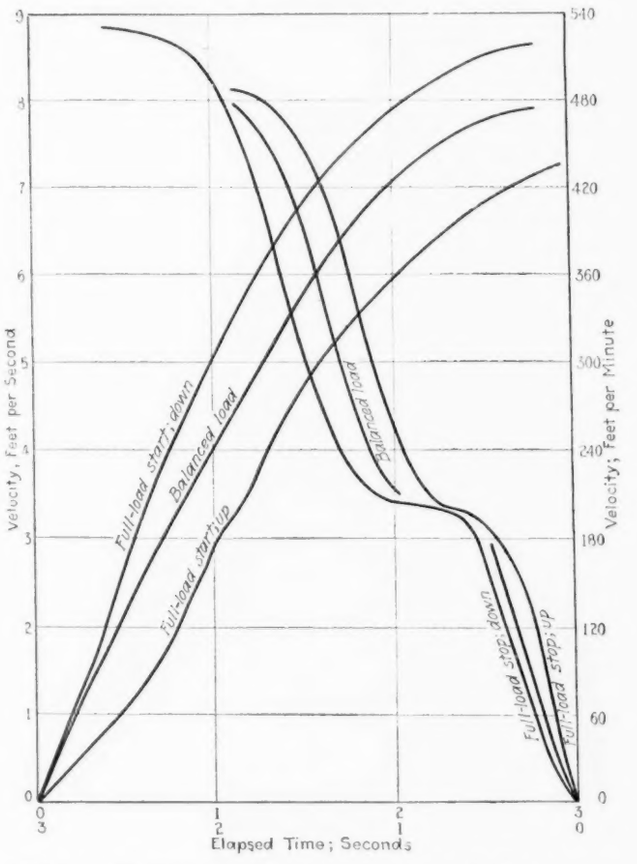

Velocity; Feet per Second
Velocity; Feet per Minute
Elapsed Time; Seconds
Full-load start; down
Balanced load
Full-load start; up
Balanced load
Full-load stop; down
Full-load stop; up
0 1 2 3 4 5 6 7 8 9
0 60 120 180 240 300 360 420 480 540
3 2 1 0 1 2 3

Fig. 4—Elevator acceleration and retardation curves

simple test. The elevator is operated through several stories, starting and stopping at each floor. The car should be started immediately after each stop, with no time interval between stop and start. The time can be determined with an ordinary watch.

Suppose that an elevator having a normal speed of 450 ft. per min. requires 32 sec. to travel 10 stories of 10 ft. each, and makes 10 starts and 10 stops. The time per story is 3.2 sec., which corresponds to a rate of acceleration of 4 ft. per sec. per sec. (See Curve *G* and Table III, Fig. 2.)

By making several trips up and down and taking the average time, it is possible to obtain fairly accurate results. The elevator should be operated at full load and no load and the variation noted. This test will also give some useful information regarding the controllability of the elevator.

After this test is completed and the time recorded, the elevator should be operated over the same distance, stopping at alternate floors. The time required for this trip, provided the rate of acceleration were maintained, would be 22.7 sec. Table III, Fig. 2, gives 4.54 sec. as the time to travel 20 ft. including starting and stopping, with 4 ft. per sec. per sec. acceleration and retardation, and this value (4.54) multiplied by 5 equals 22.7 sec. This time will not be attained, because, as has been previously shown, an elevator does not maintain a constant rate of acceleration to full speed.

Simple Way to Compute Traveling Time

The following method provides a simple means for calculating the traveling time of an elevator when the space required for complete acceleration and retardation is known: The space required for acceleration and retardation is multiplied by the number of stops and this result is added to the length of travel. The sum of these quantities is divided by the normal speed in feet per second. The result will be the traveling time, in seconds, required to make the trip.

For instance, the space required for a start and stop of a 600 ft. per min. elevator at 6 ft. per sec. per sec. acceleration is 16.66 ft. On Fig. 1, 8.3 ft. is given as the distance required to accelerate an elevator to 600 ft. per min. at 6 ft. per sec. per sec. Allowing retardation to require the same space, the total space for starting and stopping is $8.3 \times 2 = 16.6$ ft. Suppose that 10 stops are to be made and the distance is 300 ft. The elevator is accelerating or retarding for a space of $16.6 \times 10 = 166.6$ ft. This distance added to 300 gives 466.6 ft., and this quantity divided by 10 gives 46.66 sec., the traveling time required. Note that in Fig. 2, curve *H*, the time required to travel 30 ft. with start and stop under the same conditions is 4.66 sec., and this result multiplied by 10 gives the same value.

The method described in the foregoing is true because the average speed during acceleration and retardation is one-half of the normal speed, and by adding this distance to the actual distance and dividing by the normal speed, the true traveling time is obtained. This method would give an excessive amount of time if the distance between stops were less than the distance required for complete acceleration and retardation.

It would be possible to classify elevators by the normal speed and the time required to travel given distances with a start and stop, but the determination of the average rate of acceleration and retardation is more fundamental and more specific. A careful study of this factor in elevator service will reveal a conception of the laws of motion that cannot as easily be obtained by any other method.

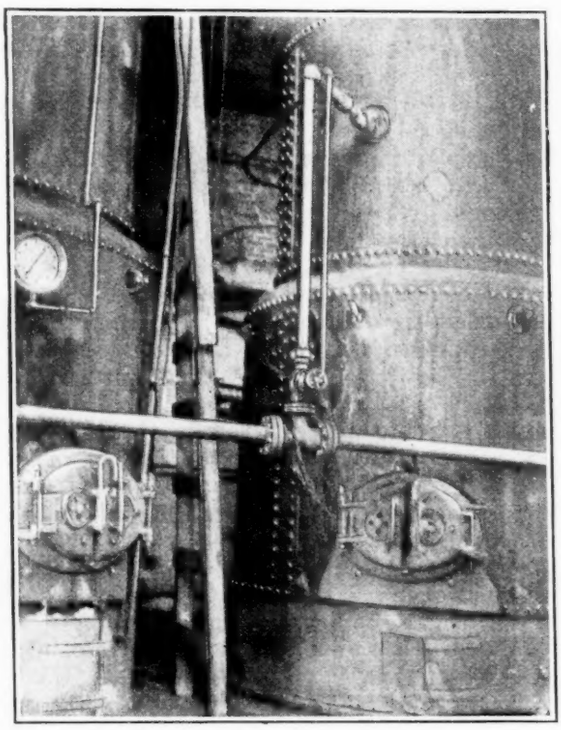
The elevator is, in fact, just a large example of the Atwood machine used widely in physics laboratories for demonstrating the laws of motion as formulated by Newton.

The traveling time of an elevator car is only one of the factors involved in the determination of the round-trip time. The time required for door operation and for the ingress and egress of passengers deserves just as careful consideration. Elevator speeds and rates of acceleration have reached nearly the highest possible point of development consistent with comfort and efficiency, while the opportunities for reducing the time consumed by door operation have scarcely been touched.

When Is Insulation Justified?

Frequently, small steam piping is left uncovered, on the theory that the heat loss through such small pipe is not sufficient to justify the cost of the insulation, which in small sizes is expensive on the basis of square feet of covered surface.

Similarly, where electric power is purchased and a small boiler is kept for emergency or heating service, insulation is often dispensed with.



Uncovered Manning boilers

It is unusual, however, to find even a stand-by plant utterly devoid of insulation, especially when of any size.

In the illustration are shown two of four vertical Manning boilers supplying steam to two 500-kw. steam turbines on a Southern plant where no pipe insulation is used and the boilers are not covered. This plant nominally is not expected to be in service, but during periods of low water it is put under load. Last year it was in operation for about nine months. It would not take much calculation to find the savings possible if the boiler shells and the steam lines were covered.

When grinding, the spider of a commutator should be made dustproof by means of a screen or else by stuffing in rags. It must be remembered that copper dust flies in every direction and should be provided against at every point. It is much easier to protect the windings and other delicate points against this dust than it is to clean it off afterward.

Decreasing Power Consumption of Ammonia Compressors

THE fact that many of the older ammonia compressors operate under decided handicaps has led to the installation of more modern units or the abandonment of the ice plant. Of all the handicaps the high power consumption of the compressor is the outstanding. The mechanical efficiency of the machines is excellent as a rule and the clearance losses even lower than in high-speed compressors. The difficulty is with the valve-port design. Designers of the past were not greatly interested in the question of valve area and were satisfied if the heavy poppet valves ran quietly. This called for a minimum valve lift, and as a result the area of the gas passage through the valve opening was so small that gas velocities as high as sixteen thousand feet per minute were not infrequent, and the pressure drop at the suction and discharge were much greater than is dictated by economy, and were reflected in high power consumptions.

Of late many of these machines, which mechanically are as good as new, have had the valve ports bored to larger diameters where this was permissible, and new light-weight valves inserted. The consequent reduction in the power consumption has fully justified the expense. Even some modern high-speed machines have been found deficient in valve area, and in such cases steps should be taken to increase the port diameter or valve area as much as is possible.

B. E. A. M. A.

SOME years ago competition among manufacturers of electrical machinery and steam turbines in England was of a "cut throat" variety, and in consequence the industry suffered seriously. None of the manufacturers was making an adequate return on his investment, and machinery of inferior quality and workmanship was produced to meet competition on the basis of low price.

To save themselves from financial disaster, the manufacturers organized the British Electrical and Allied Manufacturers Association, familiarly known as the "Beama." This is frankly and avowedly a price-fixing association. It has established standard scales of prices, with adjustments to correspond with better or worse efficiency. That is, if bids are sought on a steam turbine, a base price corresponding to a stated efficiency is established by the association, and each manufacturer then calculates his bid price in an established manner on the basis of his guaranteed efficiency. The price increments are presumably approximations to the capitalized value of the efficiency increments.

In some cases the association also establishes an "add on" to reimburse bidders for their expense in preparing tenders with the small scale often called for in Europe.

An association of this sort would obviously be impossible in the United States, because it would violate the Sherman law, but it is interesting to examine its effects in England.

It immediately put the manufacturers in an advantageous position financially and definitely averted the danger of ruin which was faced by all of them. But an unexpected consequence, entirely unforeseen by anyone, has been the shifting of competition from the realm of price to the realm of quality. In any given case now, the prices of all bidders are the same, due regard being had to the varying efficiency of the equipment offered. Accordingly, competition is on the basis of determining who can furnish the best machine for the customer's money, and as a result, during the last few years, the industry in Great Britain has risen from the production of cheap second-rate equipment to the production of machines the equal of any in the world.

A few manufacturers attempt to persuade the customer to buy inferior equipment through the furnishing of spare parts, tools and the like, that manufacturer securing the order who furnishes the closest approximation to a complete spare turbine. On the other hand, the more reputable manufacturers are genuinely striving to build the best machine they can produce. With the price-fixing scheme already established, it seems easier to persuade the customer to pay the additional money, because the scheme gives him assurance that so far as efficiency is concerned, all bids are presumably precisely equal.

Of course, conditions are different in Europe from those in America, but it is interesting to notice that a commercial association of this sort, organized purely for the purpose of safeguarding profits, has had even more beneficial effects in the strictly technical field than have been realized in the financial affairs of its members.

Procedure Control

AT THE recent annual meeting of the American Welding Society frequent reference was made to "procedure control." By this was meant in general the establishment of standard ways of doing things and, in this particular industry, standardized methods of performing the various autogenous welding operations. Leaders in the welding industry are "sold" on procedure control chiefly because it promises, where intelligently applied, to reduce the number of defective welds almost to the vanishing point. Lower production cost is here a secondary consideration.

But the advantages of procedure control are by no means restricted to the welding industry. They can be applied with advantage in almost every field of human activity. In fact, they have already been applied, under one name or another, in most fields. Without the procedure control that governed the production of each of its parts—and their assembling—the automobile would

cost several times its present price and would be less dependable at that. The symphony orchestra could not operate at all without procedure control of the most exacting type, represented by the musical score and the conductor's baton. The attractive window display, that draws one into some chain cigar store to buy the latest patent pipe, is in all probability an exact replica of hundreds of other windows all laid out in accordance with a master instruction sheet. The same is true of other chain stores. Railroads run by time-tables. Traffic control brings order out of what would otherwise be chaos.

Each of these is an example of procedure control, some more complete than others. In every case there is a twofold object—to improve the result and to allow it to be accomplished with less effort.

Where a certain routine kind of job is to be done hundreds or even thousands of times by many different individuals, it is generally possible for an expert to work out some standard procedure that will embody the best existing practice and perhaps improve upon it. With general dissemination of this standard—usually in written form—there begins a process of leveling upward. All except the hopelessly incompetent are raised to a level not far from the best obtainable in the performing of this particular operation.

Procedure control has already made a start in the power plant. In many plants standard log sheets, systematically kept up from instrument records, replace occasional haphazard scribbling and guesswork. There are printed procedure sheets covering fire and other emergencies. Machines are started and stopped according to schedules. With large and delicate mechanisms, such as turbo-generators, the method of starting and stopping is itself minutely prescribed in many plants.

There are, of course, emergencies that no man can foresee. At such times nothing but experience, resourcefulness and native good sense can save the day, but there remains a great mass of routine operations that can be carried out most easily and most successfully by following a standardized procedure. Such standards, particularly in large organizations, permit the man in charge to multiply his own skill and knowledge (assuming that he is well equipped in these respects) by the number of men employed in the plant.

Effect of Local Conditions on a Power Supply

IN THE supplying of power to industrial loads there are two extreme schools who have their advocates as to how this should be done, one maintaining that it can be most economically accomplished from a central station, and the other with equal certainty claiming preference for the isolated plant. Both are probably in error in their assertions, since if an economic study of this problem shows anything, it is that the answer lies somewhere between these two extremes. By those who take an unbiased view of the subject, it is generally conceded that there are certain classes of load that can best be supplied by a central station and others that can be taken care of more economically by an isolated plant. There is also a third class, in which local conditions may throw the economic balance one way or the other.

Local conditions are an important factor in the problem, as the article on page 706 of this issue clearly indicates. In this article it is told how the installation of a two thousand kilowatt extraction-type turbine in a paper mill is saving over fifty thousand dollars a year, when power can be purchased for eleven and two-tenths mills. At first thought it would appear that such a saving over the low rate for purchased power is out of reason, but a study of local influences shows how this was possible. First, boiler capacity was available for the turbine, so that about the only added expense in this part of the plant was for fuel and some additional maintenance. One of the boilers burns wood refuse about twelve hours a day. These conditions make for low-cost steam.

The plant is located where there is abundance of water for circulation, which makes it possible to operate the turbine straight condensing or bleed part of the steam from the lower stages, which allows operating the turbine to the best advantage. The most important condition is the high load factor at which the turbine operates, which is practically equivalent to running at full load for each working day in the year. This load factor is almost twice as high as that in many central stations and most of the industrial plants in the country and has resulted in a low fixed charge per kilowatt-hour supplied by the turbine. Furthermore, no reserve capacity had to be provided, since part of the power is purchased. These local conditions are such that even if the turbine were operated straight condensing throughout the year, the saving would be over forty-five thousand dollars.

All this establishes no precedent on which the question of buying or generating power for an industry can be settled. It is easy to conceive of conditions that would double or triple the cost per kilowatt-hour produced by the turbine. If additional boilers had to be installed, a cooling pond provided for condensing operation and the turbine used eight hours a day instead of twenty-four, the balance would easily turn in favor of purchased power. In this case the local conditions were such that a large saving could be made, and the company engineers and executives possessed the sound economic judgment to take advantage of their opportunity. This may well raise the question in the minds of many other engineers and executives in industrial plants, "Is the power supply being obtained in the most economical way or are thousands of dollars per year being lost?"

The application of heat insulation to breechings (except to portions leading to economizers or air preheaters) cannot be justified on the basis of fuel saving, as any heat in the gases is as good as lost after they leave the boiler. There are, however, good reasons for insulating breechings. These great areas of heated metal have much to do with making many boiler rooms almost intolerable in hot weather. It is unreasonable to demand intelligence of firemen and then ask them to work under conditions that few intelligent men will tolerate. In addition to this matter of comfort there may be an appreciable gain in draft due to the higher temperature of the stack gases with an insulated breeching.

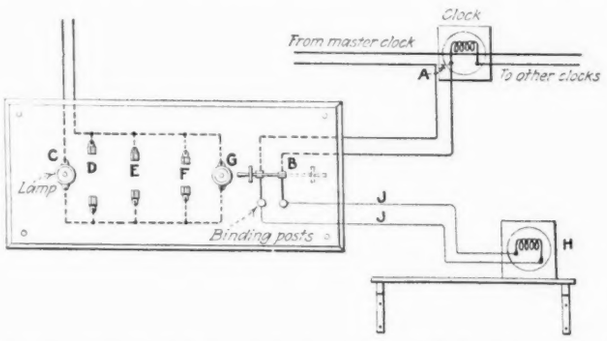
Operating performances of very large stations or giant units within such stations appear attractive on paper and are nice to talk about; but when such a station or unit, for unforeseen reasons as in several recent cases, has been compelled to run for months only fractionally loaded, the glamour fades and the fixed charges eat up the promised operating economies for a long time to come.

Practical Ideas From Practical Men

Combination Test Board for Fuses and Electric Clocks

To provide a ready means of testing fuses and adjusting our electric clocks, which run in series, controlled by a master clock, I made the test board illustrated.

The board was placed in the engine room near one of the secondary clocks. The wire at *A* was cut and run down to a knife switch *B*, on the test board,



Arrangement of fuse contacts and switch for connecting clock into the circuit

then back to the clock. When not testing, the switch *B* must be kept closed, otherwise the circuit will be broken and all the other clocks on that circuit will stop.

When testing a clock, the wires *JJ* are connected between the binding posts on the switch *B*, and the binding posts on the clock under test. The switch *B* is then opened, and the clock *H* is on the circuit. By having an extra clock, one can take plenty of time to watch it and see that it is properly adjusted.

For testing fuses the contacts *D* are spaced for 100-amp., *E* for 60-amp., *F* for 10- and 30-amp. fuses and *G* is for plug fuses and lamp bulbs. The receptacle *G* is an old socket with the threads hammered out so that fuses or lamps can be tested without the bother of screwing them in.

NELS HILSEN.

Duluth, Minn.

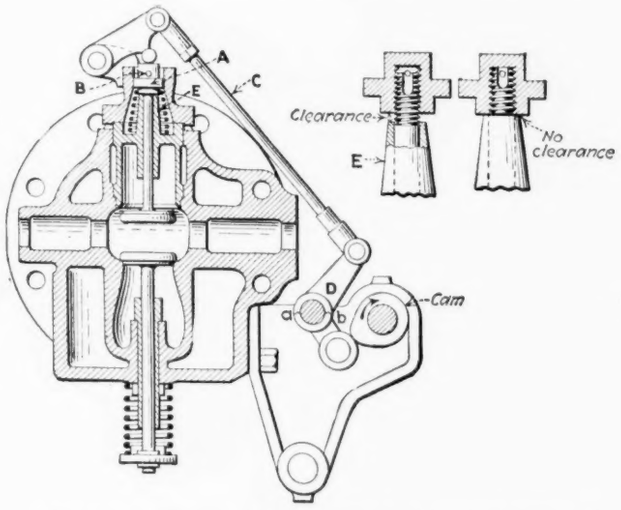
Wrecking of Gas Engines Due to Misadjustment or Faulty Operation

Bad cooling water had blocked up the water-jacket passages of a gas engine in a pumping station, with the result that the head was cracked and a new one had to be ordered. When the new head was in place, none of the repair crew or the engineers thought about turning the engine over by hand in order to make sure that all was clear, with the result that upon starting the engine the piston hit the new cylinder head, which was not sufficiently recessed, causing the frame to break across the main-bearing housings. Although the engine builder furnished a new frame, the engineer in charge lost a good reputation and a certain agricultural district was flooded and remained so for two months.

A bad case of cylinder-head failure was experienced by a hotel plant engineer. While on watch, he left the engine room, and during his absence the cooling water pump failed, cutting off the supply of water to the engine. When he came back he corrected the trouble, but instead of shutting down and allowing the cylinder to reach a safe temperature he turned the cooling water on again, which not only resulted in a cracked cylinder head, but also the engineer's dismissal and a change-over to purchased current.

After taking charge of a plant, an engineer wanted to improve the existing conditions in a hurry. He found out that the inlet valve head *A*, as indicated in the figure, was screwed down scarcely enough for the tapered pin *B* to prevent the head *A* from working lose. So he gave the head *A* a few more turns and adjusted the length of the rod *C* in order to reduce the clearance to a minimum, only to break two cast-iron levers *D* before he discovered that the normal lift of the valve could not be completed because the valve head struck the valve cage neck *E*.

In the power plant of a shipbuilding company the normal load was carried by a 160-hp. producer-gas



Lack of clearance on valve head A caused lever D to break

engine. During the war the owner bought a 325-hp. engine at a bargain, with the intention to use it for a while as a stand-by. As a matter of fact this engine was much too large for the load, and the engineer did not discover, until it was too late, that one of the piston-pin brasses ran hot, heating the entire piston slowly but surely. As the engine was dustproof inclosed, the trouble was not detected before the engine came to a standstill. The piston had scored the cylinder liner and could be removed only by means of screw-jacks.

Enschede, Holland. H. WIELAND LOS.

Suggested Crankless Engine

The success attending two different and distinct designs of "cam" engines within the last two years has induced the writer to unearth a design that was completed in 1915. No attempt has previously been made to publish, much less patent this design, as in those days cam engines were placed more or less in the same category as perpetual-motion machines and contemptuously referred to as "wobble-plates." The possibility of success with this type of engine today is due to the advances made in machine tools, metallurgy and a truer understanding of the science of lubrication.

Although details of the later designs have not been studied, it appears that double-opposed cylinders have been adopted; this system, while simplifying the design and eliminating some difficulties, can hardly fail to produce more or less severe out-of-balance conditions, and after some attempts to balance things up satisfactorily this idea was abandoned in favor of the system outlined in the illustrations.

The present design incorporates some additional features that will be dealt with as they occur in the description. In Fig. 1 is shown a 6-cylinder engine, the cylinders being grouped horizontally around the central shaft. Each cylinder contains two short pistons *P* connected through tubular piston rods to the crossheads *C*. These crossheads slide between bronze guides bolted to extensions cast on the main frame. The roller, which travels on, or rather in, the cam, is also carried on roller bearings within the crosshead. The cam consists of channels machined in the drums *D*, the shape of the cam or channel being shown in a general way in the developed curve. This curve wrapped around the drums would give the course followed by the roller *R* running within it, though the drum revolves, while the motion of the roller is only back and

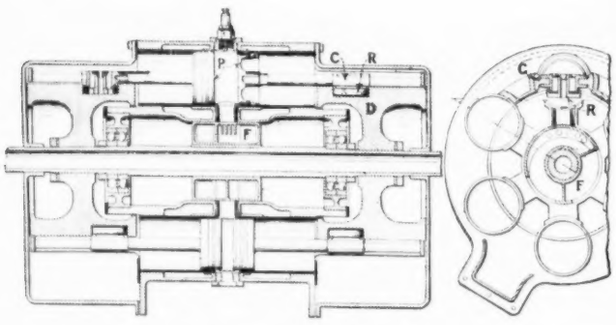


Fig. 1—Suggested design of cam engine

forth. The two drums, which serve also as flywheels in this particular design, are carried on the main hollow shaft or rotary valve set in the main frame. This shaft also carries the gas distributor.

It will be noted that on the exhaust stroke the curve falls below the base line, causing the pistons to come closer together and producing more complete exhaustion. This also leads to a certain amount of superinduction, and it will be noted that more time is given for both exhaust and induction, *BC* and *CD* being longer than *AB* and *DA*.

Two points will probably have struck the observant reader: The first, that although the roller is always tangential to the drum, the working surface or rim is parallel to the line drawn through the center of wheel and drum, but is only *on* this line at the top and bottom of the strokes. Furthermore, the inner part of the channel travels slower than the outer edge. For these reasons the sides of the channel must be formed as though by a milling cutter, and the roller must ride on a theoretical point, which can be done only by slightly curving the rim as shown.

The second point which will strike the reader is that

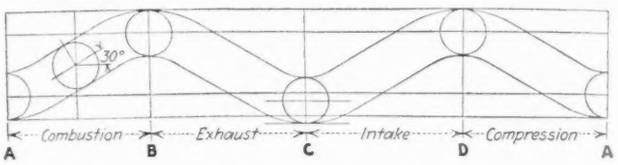


Fig. 2—Development of the drum can

under working conditions the roller will tend to reverse its direction of rotation on the induction stroke. Such a reversal at such a speed of rotation is not to be thought of, and something must be done to prevent it. There are several ways of doing this, all of which unfortunately must add weight to the reciprocating parts. This stroke, however, is a light one and the problem can be satisfactorily handled by the use of a small rolling or sliding member, which is not shown in the drawing.

J.E. REYNOLD.

C. Camargo, Chih., Mexico.

What Bid Should the Purchaser Accept?

What bid on equipment, that requires operation and maintenance charges, should the purchaser accept? It is surely a puzzle. Perhaps a little simple reasoning will help to clarify the problem.

After all, the cost factors are: Operation cost, maintenance cost, investment cost. This is the *OMI* formula that states the cost. No one factor is more important than the others. Therefore, that bid is the best which more nearly satisfies the formula,

$$O + M + I = zero$$

However, one other factor must be considered, which is adaptability. That is, the equipment might meet the *OMI* formula and still not meet future or probable modifications, extensions, rearrangements or improvements.

Under the *OMI* formula the equipment might be well adapted to present needs but too rigid or inflexible to meet future probabilities, which might mean abandonment or expensive modifications. Therefore we add adaptability to the formula and write it $O + M + I + A = 0$. That bid which best meets this formula is likely to be the best buy.

Perhaps maintenance is the most important factor to consider, because breakdowns, repairs and derangements affect the plant's production and operation and the ensuing loss can hardly be figured under maintenance.

Adaptability is the most elusive factor because it involves probability, hence should be carefully examined.

The other two cost factors, *O* and *I* (operation and interest) are easy to figure and compare in the various bids, but the decision should largely be based on the other two factors, *A* and *M* (adaptability and maintenance.

R. H. BEAUMONT, President,

Philadelphia, Pa. R. H. Beaumont Co.

Comments from Readers

Combating Slush-Ice Troubles

As to how to take care of slush-ice problems, referred to by John J. Williams in the April 13 issue, careful consideration should have been given to this when the plant was designed. I have had considerable experience in operating water-power plants that gave trouble with slush and anchor ice during the winter months. From my observations I have found that large bodies of water in the forebay will do much to prevent this trouble. It is also advisable to have the intake of the turbine well below the surface of the water, which means that the water at the plant should be deep. Slush-ice forms on the surface of the water and at a certain temperature, and will not become very deep unless pulled down by the current. When this happens it will not melt, but will freeze to the rack and parts of the turbine.

When operating a plant in Maine one winter, a good deal of trouble was experienced with slush ice. In this case the racks were kept clear by men raking them with long poles equipped with steel hooks to go between the rack bars. This same method was employed in a small plant in Vermont that I had charge of. Sometimes two or three men were necessary to prevent the racks from freezing closed.

In a 7,000-hp. plant in central New York, consisting of six 1,000-hp. hydro-electric units and one 1,000-hp. steam-engine driven unit, the operation of the plant during slush-ice periods was given up as a hopeless task. The only thing that was done was to watch the temperature until slush ice began to form, when the load was shifted to other parts on the system. In this plant I have seen the turbines practically freeze up, making the gates and other parts inoperative, in the time that it took to shift the load off the machines.

Cleveland, Ohio. G. S. PARTLOW.

Is Race an Obstacle?

After reading an article in a recent issue of *Power* on "Why Engineers Become Discouraged," the writer gave a great deal of thought to his own situation. Success does not always mean the accumulation of wealth or greatness; rather, it is the ability to serve humanity, as such men as Watt, Fulton, Bell and many others have done.

Civilization has been dependent upon the engineer to a large degree since the early centuries, and is today as much dependent as at any other time. While it is generally conceded that the colored race has not contributed anything of note to science and engineering, this is no reason why one should be denied the opportunity of pursuing such occupations. The writer, being of that race, has been employed in the steam engineering field for the last seventeen years, beginning as coal passer and finally working up the ladder, until through hard study and experience he is the proud possessor of a chief engineer's license from the State of Michigan, as well as the City of Detroit.

He has found, with but few exceptions, that being a colored man and holding an engineer's license is not an assurance of work as an operating engineer. Apparently, it matters little to the prospective employer how well a member of the race may be qualified, his chances of being given consideration in the engineering field are few. Therefore the question arises, why should those who have every opportunity imaginable become discouraged? The engineering field is broad and offers many opportunities to those who have only the barrier of qualification to surmount.

After all, colored people are not so different from others, and if given the opportunity, they might become quite efficient in the different branches of engineering. But just now few enter these branches because it has meant only a loss of time to those who have had the courage to venture. ANDREW C. MILLER.

Detroit, Mich.

[In printing Mr. Miller's communication *Power* disclaims any intention of raising a race issue and will deal with any discussions in that spirit.—EDITOR.]

Writing Yourself to the Door

The history of engineers that have attempted writing, instead of being entitled "Writing Yourself to the Fore," as recommended by P. F. Terry, Belfast, Ireland, in *Power*, March 9, should be headed "Writing Myself to the Door."

The writer was invited to accept a position as a producer of results in a large works, consisting of a large foundry and very well-equipped machine shop. The latter was doing contract work at a loss, and defective work was the rule, with a large percentage of scrap.

The plant was driven by one 75-hp. and two 50-hp. gas engines. The ignition was make-and-break and the lead, not being adjustable, was a source of trouble, as were the exhaust valves.

The writer took up the job of regulating the engines, and a series of tests to fix the revolution per minute disclosed 320 average. A gear was made to hook up my indicator, a 60-in. flywheel was used to locate the opening and closing of the valves and the ignition point on No. 1 cylinder, to which the indicator was fitted, and it was assumed that the other cylinders and valve setting would be governed by the one to be indicated.

No. 1 engine was carefully trammeled to break the dead centers on the rim of the flywheel and the valve openings were noted in inches, as was the ignition point. The latter proved to be 10 in. late, and indicator diagrams confirmed my contention that the backfiring was due to the general late valve settings. The ignition point was made 20 in. early and was left at that, so that starting would not be prevented. The engine was then loaded down and the speed set to the average of 320. After the minor adjustments, the engine ran so efficiently that the gas used the first month after the changes showed a saving of one-third over any previous month.

As the general success of every change was being noticed, the president was invited to see how simple it

was to accomplish results, and with his permission the other engines were changed later.

The desire to get away from contract work, with its high degree of uncertainty, and the closing of several orders led to a desire to produce a product that could be marketed under the company name. The writer was asked to standardize, if possible, a line of crude engines that was being built by haphazard methods.

The first engine we built was original as to general design; in fact it was considered too radical in many ways. The oiling system, perhaps the first to use pressure to all important points, was the one most condemned. A decidedly tapering water jacket contributed to the generally freaky appearance, although it was the one distinctive feature the writer introduced in his desire to get results by making conditions ideal at all points.

What was the result? A line of six engines delivered 40 per cent more power than the average power expected and three other engines were added to the line to make provision for what was to be the largest seller. The first engine demonstrated earned a $65,000 contract, dies were ordered and forging for 5,000 engines was the result.

The writer was interviewed and a story appeared as to the birth of a World's standard, which multimillionaires saw. I got a compliment for the story and another for the prettiest line of engines that appeared ready to go and compete with anyone. In ten years 55,000 were built and delivered all over the world.

Did I "Write Myself to the Fore"? Yes, that story to which my name was attached without authority earned me $23 and two offers of positions from large concerns that saw the value of my original thought. Later it developed that I was denounced for trying to be too popular. I was credited with many things. One visit to see the result of my work along with two compliments given by the visitor sealed my doom, and two months later I got my reward—I was shown the door. Belfast is not Cleveland, Ohio.

Cleveland, Ohio. JAMES MCINTOSH.

The Man and Engineering

Following with interest the discussion of E. Ogur in *Power*, Jan. 5, and the reply of Prof. A. J. Wood, which appeared in the March 30 issue, I wish to remark: It is evident at once to any impartial observer knowing the actual conditions as existing in engineering practice, that Professor Wood is under the great handicap of viewing life from the professorial chair and measuring the wisdom of his own judgment by the high ideals and non-commercialized standards immediately surrounding him.

If he would disguise his distinguished personality, not revealing his identity, and then spend eight or ten years in as many drafting and engineering departments as well, I can guarantee that he would acquire a point of view far nearer to that of Mr. Ogur than he at present admits.

He would, for example, discover in time that we have persistent, well-organized and scientific propaganda agencies which go far to mislead the public, students and prospective engineers. Most reports, statistics and general data on engineers are incomplete, unscientific, often distorted and therefore entirely misleading. For example, most engineers are naturally embarrassed to reveal their actual personal status on any inquiry blank containing their name, and consequently most data assimilated in this fashion are not only unreliable, but any generalizations therefrom should be looked upon with feelings bordering on amusement.

If Mr. Wood had a more intimate first-hand contact with the actual personnel problems of "engineering," he would be more guarded in his criticism of Mr. Ogur.

In one sentence Mr. Wood goes as far as to state and almost justify his contention of quantity production, by saying that this gives industry a better chance for selection of their 20 or 25 per cent they can possibly absorb. On this theory some engineering colleges seem to be maintained for the sole purpose of selecting a specially picked football squad. I presume that the other 75 to 80 per cent can now go ahead, after being rejected by the hit or miss process of selection, and take up a course in shorthand, piano lessons or devote their entire intellectual engineering resourcefulness in keeping track of ten latest stock movements or the doings of the latest film stars. In other words, Mr. Wood seems to be perfectly willing to disappoint the other 80 per cent in their life-career to please a few more or less unqualified selectors of industry and, of course, the other lucky 20 per cent.

I refuse to think that Mr. Wood would be so cold-blooded or hard-boiled and therefore give him the benefit of doubt in taking his statement too seriously. Did it ever occur to him that the 80 per cent could be weeded out *before* entering college without pains, instead of ten years afterward? Surely they could, but at present it seems to interfere with our deep-rooted American method of quantity production, which we have brought to such a high degree of perfection in Ford automobiles and now even carried to engineering graduates. A Ford is a cheap but serviceable car, and for exactly identical reasons the other 80 per cent of the unlucky ones, are cheap but serviceable engineers.

He goes on to say: "Fortunately, industry and engineering education are working together." This, though, of course, well meant, is one of these intangible meaningless statements which are devoid of any practical significance and must fail to bear fruit.

For a long time there has been a Society for the Promotion of Engineering Education, which has as members some of our foremost academic and industrial personages. Yet, after all is said and done, the only far-reaching practical result it has achieved during all these years is to promote quantity production about 200 per cent and quality about 15 per cent.

No individual, no society, no college and no Mr. Wood, no matter how high-minded and unselfish their ideals may be, can beat the great, unfailing, universal law of supply and demand.

Since at least 99 per cent of mortals, even of the highest culture and character, cannot live happily as human animals on ideals alone, the entire problem is really an economic one. Therefore the purchasing power of a man's income plays a most vital part in his terrestrial happiness. However, sometimes consolations help a man over great obstacles, especially if he is gifted with a Miltonian imagination.

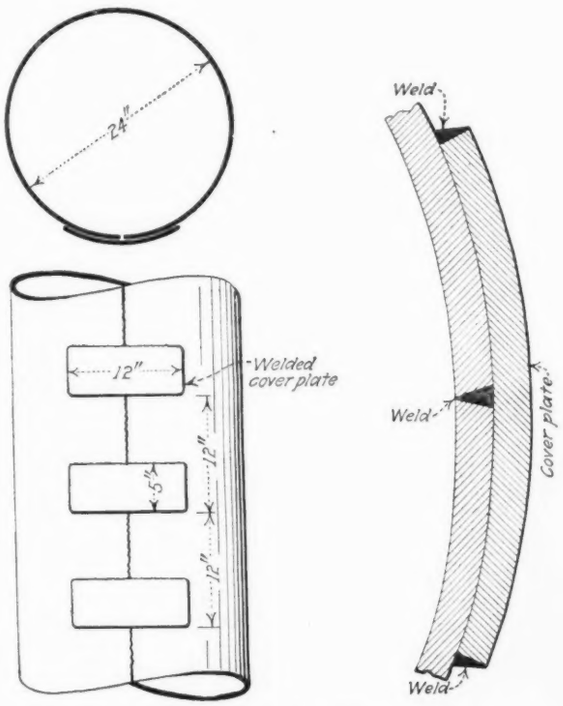
My immediate advice, which I have already pointed out in other publications, is to urge a six- or seven-year course in engineering, thus legitimately cutting down attendance and raising professional standing, to the benefit of everybody. GEORGE F. MARSTELLAR.

Boston, Mass.

Welded Pressure Tanks

Referring to the letter by W. F. Schaphorst in *Power*, March 9, in which he sounds a warning against improperly welding pressure tanks, may I draw attention to the way some well-known Swiss firms of boilermakers weld seams?

A joint may have a strength of 60 per cent of the plates and one can weld "safety covers" over the completed seam of a size to give another 60 per cent of the



Swiss method of welding tanks

strength of the plates. The resulting joint would then have a calculated strength of 120 per cent of the strength of the plates.

To show the application of this welding, assume, for example, that a cylindrical drum of 2-ft. diameter to withstand an internal pressure of 150 lb. per sq.in. is to be produced; with a factor of safety of 5 the thickness of plate would be $\frac{5}{16}$ in. and the thickness of the cover plates should be $\frac{7}{16}$ in. The number of covers will be taken as one per foot of cylinder length with a cover length of 5 in. and a breadth of one foot.

For high-pressure jobs outside and inside covers should be used. My experience indicates that the receiver in the letter referred to, was bound to explode, as only a forged tank can withstand combined strains. On the other hand, welded safety covers would have reduced the danger to a minimum. R. T. HEINRICI.

Liefing-Wien, Austria.

Thinks Hydrostatic Test Is Satisfactory

Referring to the letter of A. Bowen, in *Power*, Feb. 23, relative to the hydrostatic testing of boilers, I feel that the hydrostatic method is not reliable when used for a limited time with small pressure overload. However, the method, when properly applied, is a sufficient test.

When an overload is applied, time must be allowed for the boiler to expand enough to show any possible signs of leakage or distress. With a hydrostatic pressure of approximately 50 per cent overload, the boiler must be subjected to the strain for a much longer period of time than 10 minutes. Pressure must be held on the boiler between thirty minutes and one hour before an accurate knowledge of its condition can be had.

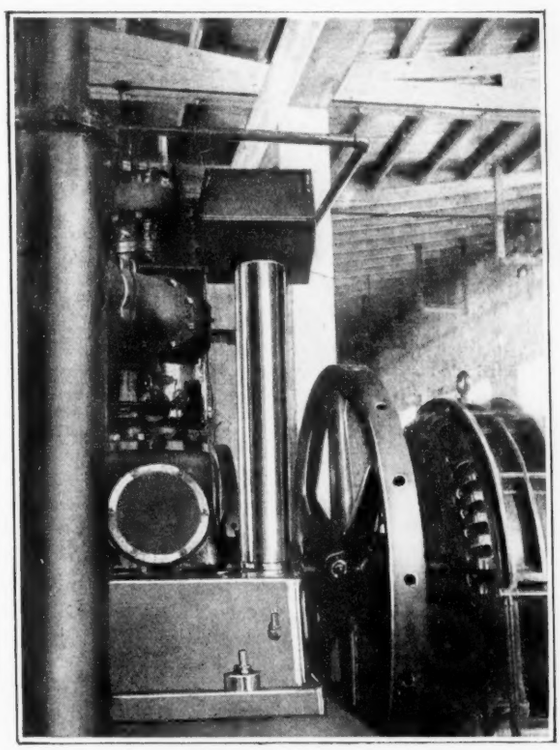
If proper facilities allow the more or less rapid variations of applied pressure, say between normal and 50 per cent overload, the length of test can be cut, as sudden strains more quickly affect a boiler than the gradual application of any certain pressure. If the hydrostatic method be given a fair chance, it will prove to be an accurate and reliable indicator of the real condition of the boiler under test.

Philadelphia, Pa. JAMES M. BRUNING.

Air Filters for Oil Engines

In the Feb. 2 issue of *Power* appeared an article on the necessity of clean air for internal combustion engines.

Engineers are coming to appreciate the advantages gained by eliminating all foreign matter from the air charge and have found that the reductions in bearing



Air going to the crankcase of this 300-hp. oil engine is filtered to eliminate sand

wear and lubricating oil consumption will repay the investment in the filtering apparatus in a short time.

In most instances the engines so equipped have been of large capacity, but of late many two-stroke-cycle engines of small powers have had filters added. In the illustration is shown a 300-hp. oil engine in the light plant at Hollywood, Fla. The amount of sand in the air during times of high wind prompted the engineer to filter the air going to the crankcase.

New York City. L. H. MORRISON.

Exhaust Steam Versus Live Steam for Heating Purposes

In J. G. Smedley's letter, page 425, March 16 issue, he evidently takes too much for granted in analyzing the comparative merits of live steam and exhaust steam for heating. That he consumes less coal when operating the engine on a light load and using the exhaust, instead of using live steam through a reducing valve, does not prove his contention. To make a fair comparison the amount of steam entering the heating system would have to be determined in both cases, and the temperature of the building also, assuming the outside temperature to be the same.

After the piston of an engine has traveled about one-fourth of its stroke, steam is cut off from the boiler until the stroke is completed. Consequently there is not a constant flow of steam from the boiler, as is the case when using live steam.

If an actual test had been conducted, would it not have demonstrated the fact that an unnecessary amount of live steam was sent into the system over a period of several hours and that the building temperature was higher than when operating the engine?

Mr. Smedley states that "when using live steam it is returned to the heater before it is condensed." Does not this again prove that too much steam is being used to accomplish the necessary results? If Mr. Smedley's contention is correct—as to slightly moist steam being more desirable for heating purposes—why not admit live steam from the boiler into a large reservoir and allow it to become "saturated" before entering the heating system? H. J. MARKS.

New York, N. Y.

There Is More in Engineering Than Dollars

The letter from Carl F. Miller in the March 23 *Power* on engineers' pay has some interesting angles. A reader might get the impression that he found little pleasure in working in a power plant. Perhaps he is one of the many that have not received the consideration due them from their employers. I have no hesitation in stating, however, that there are many so-called engineers that are overpaid if they receive ditch diggers' wages. One point worth considering is that it is quite possible to be a first-class ditch digger, or even a first-class bricklayer, and not know *A* from *B*. It is a fact that many self-styled engineers should really be working with such men. They are mentally capable only of doing work that requires but little concentration.

It seems the hardest kind of disagreeable work to them when it is necessary to use their brains in solving some plant problem. Every time there is a breakdown in equipment they curse the machinery, the plant and their employer because they are compelled to assist in making repairs—perhaps on a Sunday or on a holiday. When the same trouble materializes in a plant where there is a real engineer on the job, he will hustle around to get things repaired.

Some engineers have an inflated opinion of their own value and believe the concern where they are employed would be ruined if they were not on the job. When a man gets into this condition he is likely to be of little value to his employer and a misery to himself and to his assistant.

I have been an operating engineer for nearly thirty years and I have come across many underpaid engineers and quite as many overpaid ones. I cannot recall one efficient engineer that resigned to take up other work entirely unconnected in any way with engineering.

Because an employer failed to pay what an engineer thinks his services are worth is no reason for knocking engineering. To the engineer all engineering is good or can be made good.

C. F. Miller has stated his own case. Here is mine: From my work at engineering I have properly raised a family of nine. I have an $8,000 home. I have a paid life annuity that pays me $60 per month. Does any one know of any ditch digger or other ordinary worker who has done much better than this?

Toronto, Canada. JAMES E. NOBLE.

Burning Low-Grade Fuel

In *Power*, Feb. 23, C. B. Hudson undertook to demonstrate that coal of high hydrogen content is not as good a heat producer as a coal high in carbon. Using his own figures, the evidence is in favor of the hydrogen, as per the following resumé:

Loss in B.t.u. per pound of dry fuel =

$$9H\,[212 - t + 970.4 + 0.47\ (T - 212)]$$

When H = hydrogen fraction in the fuel.
t = coal temperature as fired, deg. F.
T = flue gas temperature, deg. F.

Substituting the values used in the problem,

$$Loss = 9 \times 0.11\,[212 - 200 + 970.4 + 0.47\ (500 - 212)] = 1{,}117.64 \text{ B.t.u.}$$

It is evident that the burning of this hydrogen releases a considerable part of the heat content of the fuel. Using 62,500 B.t.u. as the heat value of 1 lb. of hydrogen, the 11 per cent in the fuel would release 6,875 B.t.u. Subtracting from this the loss of 1,117.64 heat units, we still have a net gain of 5,757.36 B.t.u. from the combustion of hydrogen.

Suppose we have a fuel in which this 11 per cent is carbon instead of hydrogen; the burning of 11 per cent of a pound of carbon will release 1,589.50 B.t.u. Assuming that the combustion is completed in the theoretically correct amount of air, the flue gas loss from this is $(T - t) \times 0.24 \times W$, or $300 \times 0.24 \times 1.38 = 99.36$ B.t.u. Subtracting this loss from the heat released (1,589.50 — 99.36), we get 1,490.14 B.t.u. as the net production of heat resulting from the combustion of 11 per cent of a pound of carbon.

The difference, then, between the net heat from hydrogen, 5,757.36 B.t.u., and the net heat from carbon, 1,490.14 B.t.u., is 4,267.22 B.t.u. and represents the advantage of hydrogen over carbon.

As this difference represents 11 per cent, it follows that any fuel is hotter by 388 B.t.u. for each 1 per cent of hydrogen that replaces a like amount of carbon.

C. PRICE CRAWFORD,
Salt Lake City, Utah. Utah Fuel Co.

[EDITOR'S NOTE—Since the nitrogen content of the air introduced to supply the oxygen for the combustion of the hydrogen passes out the stack, it carries away an amount of heat ignored in the above discussion. A pound of hydrogen requires 8 lb. of oxygen or 34.78 lb. of air and the heat so lost becomes

Temperature rise $\times$ *specific heat* $\times$ *weight.*

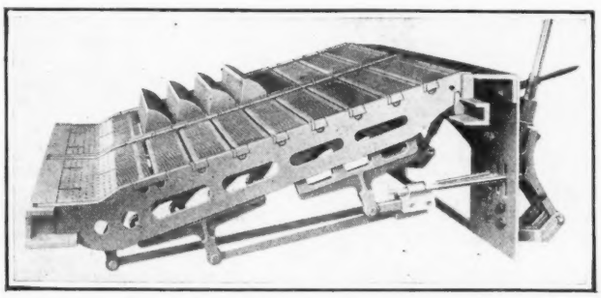
Substituting the correct values, we have

$$Heat\ loss = 300 \times 0.24 \times 0.11\ (34.78 - 8) = 212.1 \text{ B.t.u.}]$$

New and Improved Equipment

Neemes Hand-Operated Stoker

The Neemes Foundry, Inc., Troy, N. Y., has recently added to its line of shaking and dumping grates the hand-operated stoker shown in the illustration.



View of hand-operated stoker

The surface of the grate is inclined at an angle of 15 deg. with the horizontal and is composed of a number of sector-shaped grate bars carried on heavy side bars which are anchored in place at the forward end only, the lower end being free to move to provide for expansion. The extensions on the grate bars, which rest in recesses in the side bars, are covered with lock boxes which serve to hold the bars in place and protect them from the fire. The extensions, or journals, on the grate bars are large and are tapered to reduce the friction. The recesses in the side bars are provided with holes at the bottom so as to be self-cleaning. The grate-bar sections are made with a deep apron to prevent sifting of live fuel into the ashpit when the bars are operated. The slots in the bars are widened below the surface to prevent clogging with ashes.

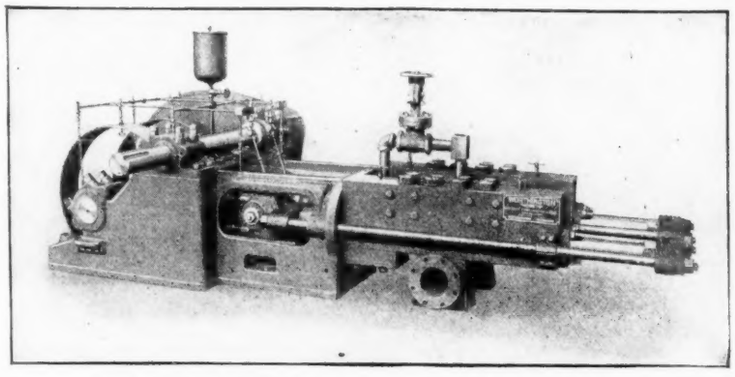
The grate bars are operated by means of levers at the front of the stoker, four bars being operated by one lever, as indicated in the illustration. The dump plate, which is designed to prevent avalanching of the fuel into the ashpit when it is down, is operated independently of the bars.

Provision is made for ready adjustment to obtain correct leveling of the grate bars. Stops on the stoker rods prevent overtravel, and a dog on the dumping toggle holds the dump plate in normal position.

Worthington Forged-Cylinder Pump

The illustration shows a forged-cylinder pump recently developed by the Worthington Pump & Machinery Corporation, New York City, for feed and auxiliary oil pipe lines.

The pumps are built in capacities up to 40,000 bbl. per 24 hour and are designed for a maximum pressure of 900 lb. per sq.in. or a normal working pressure of 750 lb. per sq.in. The pump illustrated is a 4½x12-in. duplex double-acting machine with a capacity of 6,000 bbl. a day. Its over-all length is 12 ft. 10.5 in. and its over-all width 6 ft. 2 in.

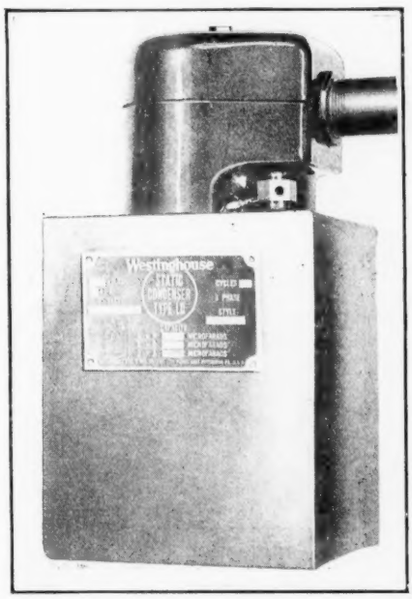


Forged-cylinder duplex power-driven pump

Each cylinder and its passages are tooled out of solid machine-steel forging, and the throats are bronze-lined with deep stuffing boxes. The valve chambers are tooled out of the cylinder forging. Steel ball valves of the enclosed type operating on hard gear-bronze renewable seats are used. Each valve is separately accessible from above through individual valve-chamber covers. The crankshaft and connecting rods of the power end are steel forgings.

New Static Condenser for Individual Motor Application

A new line of static condensers for individual induction-motor application at 220, 440 and 550 volts for two- and three-phase circuits has recently been developed by the Westinghouse Electric & Manufacturing Co. The new condenser, shown in the figure, consists of insulation and metallic sheets inclosed in a sheet-metal container and a porcelain terminal housing arranged for conduit connections. These condensers have low losses, less than one-half per cent of the unit's rating regardless of its size. Applying these static condensers at or near the motor, results in the power factor being corrected at or near the source, improvement of voltage regulation at the motor or on the feeders due to the reduction of line current and a minimum of distribution losses.



Static condenser and terminal block completely assembled

A condenser may be supplied with each motor, or the condenser may be changed from one motor to another. These condensers, which may be connected at the motor and switched on and off with it without additional attention, may be obtained in ½, 1, 2½ and 5-kva. units.

A. S. M. E. Regional Meeting in Providence

AFTER thirty-five years the Society returns to Providence with 720 registered members for a regional meeting which is virtually the Spring meeting for Eastern members who cannot go to San Francisco. Interesting and vigorous technical meetings are combined with splendid hospitality and lavish entertainment.

IN VIEW of the regular Spring Meeting of the Society being scheduled for San Francisco this year, the regional meeting held in Providence last week was especially well attended and served the purpose of those who are unable to make the trip to the Coast. The registration reached 720, a record for a regional meeting, and above the mark of many Spring Meetings.

At the luncheon on Tuesday noon, with the Providence Chamber of Commerce, Luther D. Burlingame, chairman of the Providence Section of the A.S.M.E., compared this regional meeting with its registration of 500 at that moment, with the Society meeting in Providence 35 years ago, at which the attendance of 300 was a record up to that time. Seven past-presidents at this luncheon, together with several others, were in attendance at the meeting of 1891.

Prof. R. W. Angus, of Toronto University, vice-president of the Society, responded on behalf of President Abbott, who was unable to attend. He emphasized the unity of many nations in the word "American."

Prof. H. E. Clifford, of Harvard University, spoke on the "Relation of the Engineer to Business."

He discussed prospective conditions 25 years hence, outlining certain probable modifications in industry which must follow the trend to apartment life forced upon us through increasing population. He suggested that many of the tasks now performed in the house will be transferred to outside agencies, with profound effects on our industrial structure. Changing demands from other causes were also outlined. The growing burden on our transportation facilities will in itself force modifications of the present order. The engineer's contribution during the transition will obviously be far-reaching. The author closed with an appeal for consideration of those human values which are beyond the reach of technical attainment, and which are the crowning glory of civilized life.

Entertainment Features

The clam bake on Tuesday evening was held in the little village of Rehoboth, Mass., founded some three hundred years ago by the first settlers in this section. Some 250 members and ladies partook of an elaborate repast of sea food and then gathered in the community house for an enjoyable entertainment and dancing.

On Wednesday evening over two hundred members and guests enjoyed a dinner followed by dancing in the ballroom of the Providence-Biltmore Hotel. Henry Sharpe, of the Brown & Sharpe Manufacturing Co., presided as toastmaster, and the Hon. Jos. H. Gaynor, for thirteen consecutive terms mayor of Providence, greeted the Society.

S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Co., vice-president of the Society, responded for the Society on behalf of President Abbott, who was unable to be present. The speaker of the evening was Samuel H. Libby, of the General Electric Co., who spoke on the "Engineer's Opportunity," an opportunity for service to mankind. John R. Freeman read a cablegram greeting from Calvin W. Rice, secretary of the Society, who is in Europe studying technical museums. Dancing followed and marked with pleasure the close of an enjoyable evening.

On Thursday a large party of members and guests were taken to the Naval Training and Torpedo Stations, at Newport, where they heard instructive talks by Navy officers and witnessed demonstrations of torpedo launching from boat and airplane.

Throughout the meeting entertainment was lavishly provided for both ladies and gentlemen, and the Providence Section of the A.S.M.E., together with the Providence Engineering Society, are to be congratulated for the splendid arrangements.

Industrial Power Session

Tuesday morning an enthusiastic group of a hundred or more gathered in the rooms of the Providence Engineering Society for the discussion of the power problems of the industrial plant.

Samuel D. Fitzsimmons, plant engineer, Brown & Sharpe Manufacturing Co., discussed the results of the boiler test reported in *Power* for March 16, 1926. His paper will be abstracted at length in a future issue. He recounted the reasons for the excellent efficiency of the unit (83 per cent) and expressed the opinion that with suitable design and at ratings below 200 per cent, a stoker-fired boiler will give results as good as pulverized coal.

Two hundred and fifty members and guests

The discussion of this paper, both written and oral, was vigorous and illuminating, twelve members taking the floor.

F. W. Dean, of Boston, said that the results seemed too good to be true, and expressed the belief that they were based on tests with water meters. He disagreed with the author on the importance of radiant-heat transfer, and asserted that the proportion of boiler surface exposed to radiation makes no difference in its efficiency. He fails to see any merit in the boiler tested.

E. N. Trump, consulting engineer of the Solvay Process Co., of Syracuse, pointed out that the results agreed with those of tests reported by B. N. Bump some time ago. He believes the author is right regarding radiant-heat absorbing surface, but sees no reason why the stoker should yield better results than pulverized coal. The furnace volume in either case must be sufficient to avoid chilling the flame.

James J. Tyrrell called attention to the importance of proper heating-surface distribution. Some 60 or 70 per cent of the heat may be radiated directly to 10 per cent of the heating surface. Greater radiating surface, operating at high rates of heat absorption, will reduce the total surface and the cost of the boiler. Furnace height is a function of the rate of combustion per square foot of grate area. He pointed out that the author's reference to pulverized-coal practice was confined to the "downshot" system, and said that horizontal firing with unit pulverizers called for lower air pressures and smaller furnace volumes—larger than the stoker requires, but more like the practice in oil burning. He mentioned the importance of designing walls to reflect radiation to the boiler surface.

James W. Armour, engineering manager of the Riley Stoker Co., could see no reason why the industrial plant cannot secure as good efficiencies as the central station. Even at higher rates of steaming, the efficiency could be maintained through increased investment in a longer stoker or in a clinker-grinder installation.

H. M. Burke declared the installation to be a good example of stoker application. In his opinion it is possible that a hand stoker would do as well under similarly favorable combustion rates.

W. G. Starkweather said that the height of the furnace was limited by roof trusses. He described the setting and praised the free water circulation in the boiler as an aid to good heat transfer.

In closing the discussion, Mr. Fitzsimmons said that the feed water was measured in volumetric tanks, accurately calibrated, and that temperature corrections were made throughout the test. He discussed further the advantages of radiation and thin fires and pointed out that radiation must transmit much of the heat liberated, since it is impossible for the gas to convey all the heat with ordinary limits of CO_2 and fire-bed temperature. He said further that the test results have been borne out by a saving of some $20,000 in 1925 over 1924, in spite of a somewhat greater plant output.

Power and Heat for Industrial Plants

M. K. Bryan, in a paper on "Selecting a Power and Heat Supply for Industrial Plants," discussed the basis upon which different schemes for such service may be compared, with a view to selecting that plant which will net the greatest financial return on the investment, other things being equal. Typical steam and electrical load curves were assumed for different industries, and discussed in relation to the selection of condensing, non-condensing and bleeder units, or the purchase of electricity.

Where the process steam and electrical demands practically coincide, it was shown that a kilowatt-hour could be generated by a non-condensing unit for about eight thousand B.t.u. Under less favorable conditions a power supply combining condensing and non-condensing units so arranged that the loads on each vary as the demands for process steam change, will work out to advantage. The exhaust from the non-condensing unit would supply the process steam needs, and this unit would carry a load in proportion to these steam demands with the balance of the power load being carried on the condensing machine. Such conditions are fulfilled with either the bleeder-type unit, which combines a non-condensing and condensing unit in one machine, or by the combination of non-condensing and condensing machines, or by a non-condensing machine paralleled with purchased power.

In other cases where the conditions are still more unfavorable, the author showed that purchased power was the proper solution.

He discussed further the use of heat accumulators where extremely variable process demands are encountered.

Seven members engaged in a spirited discussion in which various schemes and results were reported with accounts of difficulties met. The lack of synchronism of power and steam demands is a matter for serious study and vitally affects the problem. Tying in electrically with purchased power is a splendid scheme if it is not beset with contractual restrictions counteracting its thermal benefits. Flexibility is of primary importance in handling discrepancies in heat and power demands, and when the heat demand is largely for hot-water processes, a large hot-water storage is a cheap and effective means for securing ample flexibility. Fixed charges are of first importance in any study, and, above all, thoroughgoing analysis of conditions is indis-

attended the clambake and entertainment

pensable. John A. Stevens deplored the tendency of owners to take the advice of salesmen, without proper employment of impartial technical advice.

Central Station Power Session

The session on central station power met in the ballroom of the Providence-Biltmore Hotel on Wednesday morning, under the chairmanship of Nicholas Stahl, of the Narragansett Electric Lighting Co.

The large attendance included leaders in the field of power generation and use.

Comparative Performance of Air Preheaters

Nevin E. Funk, operating engineer of the Philadelphia Electric Co., presented the results of a series of tests on various types of air preheaters used with substantially identical boilers, with and without economizers. His discussion will be presented more fully in a future issue. The results confirm the benefit of preheated air, not only in improved combustion of volatile, but also in reduced combustible in the refuse.

With respect to air preheaters of various constructions, Mr. Funk said that the plate type is harder to clean, and to repair if leaks develop. The tubular heater combines easy cleaning with excellent performance. The Ljungstrom heater is easiest of all to keep clean.

However, Mr. Funk was emphatic in asserting that it was not his intention to present conclusions, but rather a simple collection of data secured with all the accuracy possible in a test of operating equipment. He remarked that some of the figures are unexplainable and may perhaps represent inaccurate readings or instruments so located that they fail to indicate average conditions.

Twelve men contributed written or oral discussion, much of which was concerned with detailed comments on the author's results, or with questions relative to further items concerning the apparatus and its performance.

I. E. Moultrop, of the Edison Electric Illuminating Co. of Boston, commended the author for the paper and especially for his attention to the accurate determination of unburned combustible in the refuse, a quantity seldom known with any approach to accuracy.

Temperature Effects

C. F. Hirshfeld, chief of the research department of the Detroit Edison Co., called attention to the results which show an increasing temperature of gas leaving the boiler with increased furnace temperature due to preheated air, contrary to the usual fall in exit temperature with increased furnace temperature due to decreased excess air. Further study will doubtless reconcile the apparent discrepancy.

Preheated air, said Mr. Hirshfeld, leads to more complete combustion, but he wondered if water-cooled walls would have a counteracting effect. They permit higher furnace temperatures, promoting combustion, but may have a local cooling effect, tending to increased combustible in the refuse.

Otto DeLorenzi, chief engineer of the Combustion Engineering Corp., presented a detailed analysis of heat transfer in air heaters, and called attention to the importance of duct layout to give proper air and gas distribution. He said that the experience of his company had shown that no trouble need be feared from either corrosion or cleaning difficulties in plate-type heaters.

J. W. Landis, research engineer of the Brooklyn Edison Co., described elaborate studies of air flow in which it was found that the velocity distribution in the fan discharge was not at all as expected, and that the issuing stream did not diverge more than 14 deg. included angle. The installation of directing vanes, adjustable after operation begins, is the solution he came to.

C. A. Jacobson declared leakage to be small in the Ljungstrom heater and pointed out the advantage of this device in that its surface works uniformly, without localized hot or cold spots. No portion can remain below the dew point of the flue gas.

W. E. Caldwell, of the United Electric Light & Power Co., said that in their experience carbon in the refuse can be held to a very low value with low ratings and low air pressures, but that with high blast pressure they find it impossible to keep this loss down.

Author's Closure

In closing the discussion, Mr. Funk mentioned a number of matters in response to specific questions. How high furnace temperature can be carried with water-cooled walls he does not know, having thus far made no efforts in that direction. The coal burned in the tests reported was from Clearfield County, Pa., with an ash fusion temperature of about 2,500 deg. F. During the tests, air at 300 deg. F. gave appreciably better fires than cold air, and the troubles experienced with hotter air can, he believes, be overcome through the use of water-cooled walls. He has no data on the effect of water-cooled walls on combustible in the refuse, but believes that this will prove slight. He reported initial difficulties with faulty air distribution in the preheaters, which were entirely removed by the use of suitable directing vanes. Air handling in preheaters is always handicapped by space limitations, he said, and by the sensitiveness of air flow to seemingly slight influences. He believes that air leakage in the Ljungstrom heater is about 10 per cent. With respect to the heat-transfer results, Mr. Funk said that during these tests an unknown amount of cold air was used to cool perforated carborundum side-wall blocks, and this diversion affected air-heater operating results by reducing the relative air quantity. The air ducts are all well lagged, and no apreciable temperature drop has been observed. Space requirements are shown by the cuts, which are to scale. Power requirements for the several types of heaters do not vary greatly.

In conclusion, Mr. Funk reiterated his statement that these tests were not of a laboratory nature and that the results are not set forth as highly precise, although they are as accurate as could be obtained under operating conditions. He holds no brief for any design or type, but is simply presenting the results of his observations for whatever they may be worth.

The paper on "Boiler and Stoker Performance at the Hell Gate Power Station of the United Electric Light and Power Co.," by H. W. Leitch, was presented by W. E. Caldwell, Mr. Leitch being unable to be present. The paper, which will be abstracted fully in a later issue of *Power*, presents the results obtained with new and old boiler equipment.

In a discussion read by Mr. Gates, H. N. Broido, chief engineer of the industrial department of the Superheater Co., pointed out that the paper shows that a stoker with adequate combustion volume and grate area shows efficiencies as good as those reported for pulverized coal. The question is whether they can be maintained in practice. Water-cooled walls do not seem to retard combustion, and Mr. Broido believes that more surface could be installed without bad effects. It appears that at high ratings the last passes of the boiler must work with increased effectiveness, due to higher gas velocity.

L. J. Levit, of the United Electric Light & Power Co., presented an analysis of boiler losses which will be presented in a later issue of *Power*.

H. B. Reynolds, of the Interborough Rapid Transit Co., presented the paper on the "New Boiler Equipment at the Interborough Rapid Transit Co.'s Fifty-Ninth Street Power Station," by Messrs. H. B. Reynolds, J. M. Taggart and R. S. Lane. This paper was presented on Feb. 24, 1926, before the Metropolitan Section of the A.S.M.E., and was reported in *Power* for March 23, 1926. Mr. Reynolds described the installation briefly.

At the close of the session P. C. Idell, of the Babcock & Wilcox Co., presented resolutions of appreciation to the Providence Section for their successful entertainment of the Society.

According to the 1926 report on boiler and turbine room instruments, issued by the N.E.L.A. Prime Movers Committee, electrically operated reducing valves with automatic control are now being used. The balance between low-pressure and high-pressure steam lines is maintained by means of mercury columns on the low-pressure and high-pressure mains. The device holds a constant steam pressure on the low-pressure system. Mercury contacts are used to make and break the circuit to the contactors controlling the operation of the motor on the valve. An orifice is also installed between the reducing valve and the low-pressure header, so as to limit the amount of steam to the maximum desired. The valve can then be opened to the full extent without taking an excessive amount of steam. The low-pressure header is also protected against excess pressure by means of safety valves. The committee recommends the use of a so-called absolute-pressure thermometer inserted in the turbine exhaust. One form of this instrument is graduated on one side of the scale from 50 to 110 deg. F., and on the other in inches of absolute pressure. The scale is so open that in the neighborhood of 1 in. absolute pressure a tenth-inch difference in pressure means a movement of the mercury column of nearly a half-inch.

The Design of Welded Joints*

By S. W. Miller
Consulting Engineer, Union Carbide & Carbon Research Laboratories

IN ANY industrial process success is obtained only by following a definite procedure. In many cases this is done unconsciously rather than consciously, because experience has shown that certain things must be done if success is desired. Welding processes are not in any way different from others, and if it is expected that success should be attained, a definite procedure must be established as in other cases. It is convenient to apply the term "procedure control" to cover the various steps and items that are involved in successful work, and it has been found by experience that when the procedure control has been definitely established on a sound basis, success is inevitable. The various steps in this control may be considered to be the following:

1. *Workmanship:* Workmanship includes everything pertaining to quality of the welding and the determination of the ability of the welders. In important cases tests of the welder's ability should be made by breaking test pieces either in a testing machine or by bending.

2. *Materials:* Materials include both the metal in which the weld is made and the welding rod used. These tests would be such as to determine whether the materials are of suitable quality and whether they meet the specifications under which they may have been procured.

3. *Design:* The design of a welded joint is of great importance, not only for strength but for ease and cheapness of manufacture, and the designer must often depart from the usual methods of joining if he expects to get the best results from welding.

4. *Preparation:* This covers all such matters as jigs, fixtures and other work preparatory to doing the actual welding.

5. *Welding:* This includes everything in connection with the actual welding operation, such as the methods by which the parts are tacked and welded, allowances for shrinkage, the order in which different parts of the work shall be done and the supervision of welders.

6. *Testing:* In this are included any usual or unusual methods of test that may be devised to meet the requirements of welded structures.

Each one of these, like links in a chain, must be of the proper strength, that is, satisfactory in all respects if the result is to be equally satisfactory. At the present time, design, which is just as important in welded structures as in any other, will be considered, and as one of the most important general divisions of welding is that of steel plate, it will probably be well to confine our attention to that branch.

There are four commercial qualities of steel plate—firebox, flange, ship and tank, and all of them are easily available in the market. All of them, also, except tank plate, are made under different specifications such as those of the American Society for Testing Materials. Tank plate, so called, has no definite specification, and in it may be found materials varying widely in chemical composition and physical properties.

It will be enough to say here, in order to avoid going too deeply into the question of materials, that tank steel is not good for important welded structures as its welding qualities are frequently undesirable and as the welds made in it will probably be inferior.

For welding, it is important that high quality material be used for the best results, and, therefore, fire-box steel, which is the best grade, is most suitable for important work.

It is well known that the lower the carbon content of a piece of steel, the more readily it stands heating and cold work without injury. This is particularly true of heating, and as fusion welding involves a considerable amount of heating, we would use preferably a low carbon material. My personal belief is that material for welding should at the present time contain not over 0.15 per cent carbon.

In any structure that has none of its parts heated, advantage may be taken of the cold work in the design. That is, the strength of the material as rolled may be used as a basis for the design, but as heating removes the effect of the cold work, any strength imparted by cold work should not be considered in any structure that is heated. For instance, in flanging a boiler sheet, heat is applied and the strength of the flanged piece is not the same as before flanging. Under certain conditions, it may be greater, but usually it is weaker; exactly what happens depending upon the duration of the heat and its intensity. In the same way, steel structures that are fusion welded should be designed on the basis of the strength of the metal that has been heated if this is less than that which has not been heated. Of course, if it is greater, the strength of the sheet itself governs the design.

The strength of the weld metal in a fusion weld when it it made with ordinary low-carbon steel welding wire and of the double V type, is about 50,000 lb. per sq.in. Now if the plate be of 50,000 lb. tensile strength, the efficiency of the joint would be 100 per cent. If however, the strength of the plate be 65,000 lb., the efficiency of the joint would be only 77 per cent. Two things, therefore, are clear—first, that the term, "efficiency of the joint" should be used only in connection with welded structures when a thorough understanding of what the term really means is had. Second, that in testing welders, the tensile strength of the plate used must be known if fair comparisons are made, and justice is to be done to the different men.

It seems clear, therefore, that the only fair basis for design in the case of welded structures is to use a maximum working fiber stress based either on the tensile strength of the plate or on the tensile strength of the weld metal, whichever is the lesser. This brings us to another important point, which, although it has been brought out in the foregoing, may be restated in different words to make it more clear.

Using a rather exaggerated case—a 50,000-lb. weld in a 50,000-lb. plate is just as strong as a 50,000-lb. weld in 100,000-lb. plate, although the efficiencies in the two cases are 100 per cent and 50 per cent. In the first case, theoretically, the rupture may occur in either the weld or the plate, but in the latter case it will always occur in the weld. This shows us that there is no advantage in using plate of higher tensile strength than that of the weld metal. It also shows that there is no decrease in thickness with high tensile strength plate.

It is, of course, quite desirable that we be able to produce a weld that will be equal in strength to the highest tensile strength plate that can be obtained, and this has been done in experimental work. There is, however, the difficulty of welding high-carbon plate, the carbon of which gives it its high strength, and until these difficulties are overcome by the development of proper procedure controls, we are better off to use a low-carbon plate that we are sure will give perfect safety.

My belief is that the double-V type of weld is always superior to the single-V type. There is a strong tendency in any single-V weld, particularly when made with ordinary welding materials, to be imperfect at the bottom of the V. In addition to this, reinforcing the weld, that is, adding metal to one side, throws the line of resistance of the weld metal to one side of the line of application of the stress. This results, of course, in eccentric loading, and it is well known that this increases the stress at the bottom of the V to a very high point. It may be also pointed out that even if the weld be sound and entirely fused at the bottom of the V, there is a different amount of weld metal at the top of the V than at the bottom, and that the physical characteristics of a section at the top and bottom of the V are different because of the difference in characteristics between the base and weld metals. Further, my experience convinces me that the weld metal at the bottom of the V is never as good and as sound, even when thoroughly fused to the base metal, as it is in the upper part of the weld—so that as I stated before, I am thoroughly convinced that a weld of the double-V type is superior to one of the single-V type.

The tests of pressure vessels at the Bureau of Standards that were sponsored by the American Welding Society show that with the materials used, it was perfectly safe to use a maximum working fiber stress of 8,000 lb. per sq.in. for a double-V weld, and, therefore, the Welding Society recommended that this be used as shown on Page 3 of Bulletin No. 5. The Bulletin also shows the derivation of this figure on Page 12, under the heading "Design."

The average bursting strength of the regular tanks with double-V welds was 50,000-lb.—using a factor of safety of 5 or a working stress of 10,000 lb. and allowing 20 per cent for irregularities in workmanship gave the figure 8,000 lb. It would certainly seem that this is not too high a figure for safety.

*Abstract of paper presented at annual meeting, American Welding Society, April, 1926.

News in the Field of Power

Passage of Coal Bill Expected Soon

Assurances have been given the President by Chairman Parker of the House Committee on Interstate and Foreign Commerce that a coal bill will be reported by his committee and pressed for passage at this session of Congress. The President has been advised further that a majority of the committee have come to an understanding as to the principle of the bill that will be recommended, although the details have not been worked out as yet.

It was stated at the White House that this information is gratifying to the President and that he thinks Congress should enact legislation at this session along the lines indicated.

As House leaders had promised earlier in the session to give coal legislation a chance, a special rule doubtless will be forthcoming which will insure a vote on the measure at this session.

Any coal bill recommended by the committee is likely to pass. The Committee on Interstate Commerce, as now constituted, enjoys high prestige in the House. This means that many members who will not have had an opportunity to study the bill, will vote with the committee. Moreover, any champions the coal industry may have among the members of the House do not seem to be aggressive.

Little Difficulty Foreseen

When Representative Jacobstein made his speech in the House on April 27, a fine opportunity was presented to call to the attention of a large attendance of the membership the arguments against the constitutionality of the proposals made by the New York Congressman. As it was, ten members participated in the debate, but their object was not to disagree with the conclusions of Mr. Jacobstein, but to bring out additional points to support his contentions. No champion of the coal industry arose to point out the vulnerable spot in the New York legislator's argument. This tends to confirm the opinion that no great difficulty will be experienced in getting a coal bill through the House.

Senate Action Slower

In the Senate interest centers on other things. The prospects for action are more remote. A subcommittee of the Committee on Education and Labor is considering all the coal bills in the hope that they can revamp the Copeland measure into such form as will meet the approval of the full committee. Some of the provisions of the Oddie bill probably will be attached to the legislation which may be reported out. The chances are that any bill that this committee may report will be less acceptable to the Senate than the bill likely to be presented in the House. The Senate, however, is in no humor to take up new business likely to provoke long debate.

The most significant point in the situation, however, is the fact that a bill passed by the House at this session will be before the Senate when Congress meets in December.

David M. Dillon, Pioneer In Steel Boilers, Dies

Following a prolonged illness and in the eighty-fourth year of his age, David M. Dillon, president of the D. M. Dillon Steam Boiler Works, of Fitchburg, Mass., and one of the founders and directors of several New England industries, died at his home in Fitchburg on April 28.

A pioneer in the steam boiler field, Mr. Dillon conceived, planned and made the first steam boiler constructed of steel. This was built for the Mechanics Fair in Boston, held in the upper story of Quincy Market in 1874. Widely criticized at the time for substituting steel for iron, he was, of course, as widely acclaimed some years after for his foresight and independent spirit of conviction.

Among the industrial undertakings

David M. Dillon

Mr. Dillon organized or partly organized, besides his own company were the Fitchburg Co-operative Bank, the Parkhill Mills, the Cleghorn Mill, the Orswell Mills, the Grant Yarn Works, the Brown Bag Filling Machine Co., the Nockege Mills, the Shireffs Worsted Co., the Fitchburg Horn Goods Co., and the Fitchburg Yarn Co.

Born at St. John, New Brunswick, April 15, 1843, Mr. Dillon came to this country in 1860, to work first in Boston and later in New York. During the Civil War he served in the U. S. Army at Port Royal, S. C.

A.S.H.V.E. Convention Plans Honor To Past Presidents

As an outstanding feature of the thirty-second semi-annual meeting of the American Society of Heating and Ventilating Engineers, convening at Lexington, Ky., from May 26 to 28, will be the presentation of past-president emblems to seventeen members who have served the organization in that capacity since 1895.

Important among the technical papers delivered at the business sessions are "Friction of Water in 90 and 45 Degree Elbows," by F. E. Giesecke, University of Texas; "Some Results in Heat Transmission Investigation," by F. B. Rowley, University of Minnesota, and "Rational Ventilation," by Dr. J. E. Rush, of the University of Kentucky. Reports of Technical Advisory Committees by the Committee on Research will also be given.

The social side of the meeting will not be neglected, as a golf meet, a theater party, a ladies' luncheon and bridge party, an automobile tour of Lexington and environs, and a carnival at the College of Engineering of the University of Kentucky have been planned to temper business with pleasure.

The past A.S.H.V.E. presidents to receive the emblem are: Stewart A. Jellett, 1895-96; Henry Adams, 1899-1900; D. M. Quay, 1900-01; J. H. Kinealy, 1901-02; John Gormly, 1906-07; C. B. J. Snyder, 1907-08; J. D. Hoffman, 1910-11; Reginald Pelham Bolton, 1911-12; John F. Hale, 1913-14; Samuel R. Lewis, 1914-15; D. D. Kimball, 1915-16; H. M. Hart, 1916-17; J. I. Lyle, 1917-18; F. R. Still, 1918-19; W. S. Timmis, 1919-20; E. Vernon Hill, 1920-21; Champlain R. Riley, 1921-22; and J. R. McColl, 1922-23.

California Water and Power Act Comes Up Again

A third attempt is to be made to pass the California $500,000,000 water and power act, which was defeated at the polls in 1922 and again in 1924. An initiative measure, which its sponsors plan to put on the November ballot is now in the hands of the attorney general's office for titling.

Although the act has not been compared with the previous measures, it is understood that it is to be identical with that twice defeated.

The bill if enacted would give a board of five power to spend proceeds of a $500,000,000 bond issue to put the state into the power business. It is said that Rudolph Spreckels will again finance the campaign. There is some talk of tying up the gubernatorial race of Lieutenant-Governor C. C. Young with the water and power act. The bill was defeated in 1922 and 1924.

John Hays Hammond Given Birthday Ovation

Celebrating the seventy-first birthday of John Hays Hammond, pioneer mining engineer of world fame, a large dinner was given at the Waldorf-Astoria, New York, on May 3. In tribute to "the internationalist," as Charles S. Thomas, former Senator from Colorado, toastmaster of the occasion, put it, "the first among all engineers of this country," a host of friends, and past associates, including many notable men in other lines of industry, were present to do honor at this brilliant and unusual affair.

In the past as a contributor to the development of what today is the Union of South Africa, and down through the years, past the World War period when Mr. Hammond served as chairman on the United States Coal Commission, a number of noted personages described and praised the career and accomplishments of the guest of honor.

On the dinner committee and among those present were: John J. Carty, Chauncey Depew, Coleman du Pont, Arthus S. Dwight, Charles Dana Gibson, Simon Guggenheim, Arthur Twining Hadley, D. C. Jackling, George F. Kunz, James H. McGraw, Charles F. Rand, George Otis Smith, J. E. Spurr, and William Howard Taft.

Thousands of congratulatory cables and telegrams were received, among them greetings from President Coolidge and several members of the Cabinet.

Metric System Plan Checked Again

Another effort to secure legislation intended to increase the use in this country of metric weights and measures has failed. After public hearings, at which the proponents and the opponents presented extended arguments, a majority of the Committee on Coinage, Weights and Measures of the House of Representatives was unwilling to recommend the bill providing for a restricted use of metric measures after nine years.

A bill proposing that the Bureau of Standards investigate and report on the matter was voted down.

This latter bill went to the Senate.

Stamp Issue As Memorial To John Ericsson

Simultaneously with the first award of the newly founded John Ericsson medal for achievement by Swedish-American engineers, to be made May 29 by the American Society of Swedish Engineers, at the unveiling of the memorial statue in Potomac Park, Washington, an issue of 15,000,000 five-cent stamps as a memorial to the inventor will appear under authorization by Postmaster General New.

The stamp, an upright rectangle, bearing American and Swedish shields in the upper corners, pictures the statue and carries the inscription, "John Ericsson Memorial." It will be on sale in New York, Chicago, Minneapolis and Washington the day of the celebration.

McGraw-Hill Co. Acquires Another Publication

Beginning with the June issue, *Successful Methods*, a magazine for construction service, formerly published by Successful Methods Inc., S. T. Henry, president, will be operated by the McGraw-Hill Publishing Company.

This paper will be continued as a monthly magazine of special interest to the field men concerned with actual construction operations and certain industrial activities that involve the same methods and equipment. Its acquisition is planned to supplement and extend the service now rendered through *Engineering News-Record*.

Association des Ingenieurs Invite A.S.M.E. to Brussels

A cordial invitation has been received at A.S.M.E. headquarters from the Association des Ingenieurs, of Brussels, urging members of the Society to attend the 50th anniversary of the founding of the association in June.

T. A. Vander Willigen has been appointed honorary vice-president to represent the A.S.M.E. at this Brussels scientific congress.

Muscle Shoals Bill May Pass Present Session If Pushed

An increasing determination to pass the Muscle Shoals bill at this session of Congress is in evidence in the Senate. When the Joint Committee first recommended the acceptance of the offer made by the associated Southern power companies, there was much talk that the opposition would be sufficiently strong to prevent action, despite every effort made to expedite business in order to permit adjournment at the earliest possible date.

The principal opposition comes from those Senators who believe in public ownership. In spite of some intimations to the contrary it is believed that this group will place every obstacle in the way of the legislation, but if the Muscle Shoals bill is called up immediately after the railroad labor bill, as is now planned, a filibuster against the measure may be discouraged.

It is expected that the fertilizer industry will oppose the legislation. The policy of the National Fertilizer Association, however, has not been determined as this is written, but the executive committee of that organization has the matter before it and is expected to make an early report.

Sacramento Plans Leasing of Power Development

Three plans for the development of power in connection with the Silver Creek domestic water supply project of the City of Sacramento, Calif., have been submitted to the board of directors of the Municipal Utility District by the group of engineers reporting on the feasibility of power development.

Before making any definite recommendations as to the power-plant capacities, the board of consulting engineers desires information as to the possible revenue that may be derived from the sale of power. This information is requested as a guide in the deliberations of the board as to whether the district shall develop or distribute electric energy, or lease the use of this developed water to private companies, who would install the necessary power houses and appurtenant works for the development of power.

Delegates to the New York meeting of the International Electrotechnical Commission at Westchester-Biltmore Country Club, Rye, N. Y. They have just returned from a tour of Eastern cities

Danish Power Stations Increase Capacity

There was 470 electric power stations operating in Denmark during the fiscal year 1923-24 according to a recent survey prepared by the Danish statistical department. Of these 121 were city plants and 358 were located in rural communities.

Although practically all of the city plants were constructed prior to the war, nearly one-third of the rural plants were built during or since the war. In the case of the city plants, it has been the policy to expand to take care of increasing needs rather than to establish new stations. The rural plants, it appears, are chiefly organized as co-operatives, while the plants in the larger cities are usually owned and operated by the municipality.

The horsepower of Danish plants increased from 190,000 to 228,000 during 1923-24. Of this increase 26,000 hp. was in steam installations and 12,000 hp. was in Diesel motors.

During the year under review, 231,000,000 kw.-hr. were delivered to the lines. Rural station lighting rates range from 50 to 60 per cent higher than the lowest town rates and the power rates are 150 per cent higher.—*Commerce Reports.*

Rockland Light & Power Co. Newly Consolidated

The Public Service Commission of New York has authorized the consolidation of the Rockland Light & Power Company, Orange County Public Service Corporation, Inc., and Catskill Power Corporation into a single corporation to be known as the Rockland Light & Power Company.

The Rockland Light & Power Corporation has been authorized to issue at this time $5,150,000 par value of its common capital stock and $100,000 par value of 6 per cent cumulative preferred capital stock to be sold at not less than par.

Plattsburg Gas & Electric Annex Three Systems

Purchase by the Plattsburg Gas & Electric Co., Plattsburg, N. Y., will include the franchises, works and systems of the Chasm Power Co., of Chateaugay, the Champlain Electric Co., of Champlain, and of Norman I. White, of Ellenburgh.

The three systems serve a wide territory in Franklin and Clinton counties, and it is proposed to link them with the Plattsburg plant.

Utah and Idaho Plan Water Power Development

The City of Twin Falls, Idaho, has applied to the Federal Power Commission for a preliminary permit covering a 7,000-hp. development on Snake River in Twin Falls county.

The Utah Power & Light Co. has applied for a license to cover its constructed plants on Upper and Lower Mill Creek in Salt Lake County, Utah. When this is secured operations will begin.

Personal Mention

I. E. Moultrop has been promoted from superintendent of construction to chief engineer of the Edison Electric Illuminating Company of Boston.

Col. J. W. Fuller, president of the Fuller Company, announces that his offices are now established for the transaction of business in the Fuller Bldg., Catasauqua, Pa.

Ambrose Swasey will be tendered a testimonial dinner by the Cleveland Section of the American Society of Mechanical Engineers at the Hotel Cleveland, Cleveland, Ohio, May 14.

John Abner Snyder reports that he has left the Pennsylvania Power & Light Co., Hepburn St., Williamsport, Pa., and is now with the East Pennsylvania Electric Co., Pine Grove, Pa.

G. A. Ungar, consulting engineer on bearings, lubrication and automotive problems, is now located at 40 East 34th St., New York City.

Major Glen E. Edgerton, chief engineer of the Federal Power Commission, is visiting the hydro-electric plants on the Coosa, Talapoosa and other Southern streams.

Alex Dow, president of the Detroit Edison Co., and James W. Parker, chief engineer of the company, are visiting in England for the renewal of personal acquaintanceships and for the study of power-plant engineering practice in that country.

William C. Connelly, president of the Daniel Connelly Boiler Works, of Cleveland, has recently been elected one of the fourteen directors of the Cleveland Chamber of Commerce. Mr. Connelly is well known in the boiler manufacturing industry, having been president of the American Boiler Manufacturers Association for four years.

Homer L. Rank has severed his connection with the Bonnot Co. and is now sales manager of the fuel pulverizing department of the Strong-Scott Manufacturing Co., Minneapolis, Minn., manufacturer of the "Unipulvo" system of fuel firing.

Prof. Collins P. Bliss has recently been made Associate Dean of the College of Engineering by the New York University Council. Professor Bliss, who has been a member of the faculty of New York University since 1900, is professor of mechanical engineering. He is a member of a number of scientific and engineering societies, among them the A. S. M. E., which he joined in 1903.

Society Affairs

The Indianapolis Section of the A.S.M.E., meeting at the Hotel Severin on May 18, will be addressed on the subject of "Fuel Injection Engines" by P. L. Scott, chief engineer of the Super-Diesel Tractor Corp. Election of officers for 1926-27 will be held also.

Trade Catalogs

Stoker—McClave-Brooks Co., Scranton, Pa. The McClave universal mechanical stoker for all grades of bituminous and lignite fuels, is described in a new catalog which is adequately illustrated.

Softener, Water — The Cochrane Corp., 17th St. and Alleghany Ave., Philadelphia, Pa., has recently issued Bulletin No. 665, covering the zeolite water softeners made by them. Beside other material the pamphlet contains instructions for determining the proper size of zeolite softeners and the best arrangement, that is, whether single, double or triple unit, also the instructions for calculating hardness to the basis of calcium carbonate and for using the standard soap solution test.

Spray Cooling—The Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. Catalog N-613, which describes the spray-cooling methods, featuring Yarway Type B, involute spray nozzle with conical orifice and special fittings, manufactured by this company, has recently been issued. Many attractive illustrations of installations are included.

Pyrometers, tachometers, etc.—The Brown Instrument Co., Philadelphia, Pa. New features of the Brown product to be noted are: New design recorders, single, duplex and multiple; moisture-proof rotary switch, also dust-proof, assuring positive contact, new Champion Sillimanite Thermocouple Protecting Tubes, made of Champion Spark Plug Porcelain. Descriptive and illustrative booklet, 80 pages, 120 figures and charts. Catalog 15.

Thermometers—The Brown Instrument Co., Wayne and Windrim Aves., Philadelphia, Pa. Catalog No. 92, "Resistance Thermometers," for measuring temperatures from 300 deg. + 1,000 deg. F., indicating, recording and controlling is well illustrated and the descriptions cover adequately these instruments.

Boiler Tubes — Boiler Tube Co. of America, Park Building, Pittsburgh, Pa. A tabulated price and style list of straight and bent tubes for all types of boilers. The causes and prevention of tube failures are discussed. Special features and details in design and material are stated. Special catalog.

Valves—Homestead Valve Manufacturing Co., Homestead, Pa. This is a fully illustrated and descriptive booklet of many styles of valves in Homestead brass, semi-steel, bronze, cast steel and stainless steel. The latest designs embody developments and improvements in the cam in the quarter-turn valve, and the introduction of a lubricated type valve, also development of the Homestead protected-seat hydraulic operating valve. Catalog 33.

Valves—The Ashton Valve Co., 161 First St., Cambridge "C," Boston, Mass. Pop safety and relief valves, pressure and vacuum gages, locomotive and power plant specialties manufactured by this firm are described in a well-arranged catalog of 176 pages. Good illustrations and an index add to its value.

Business Notes

Ballard Sprague & Co., Inc., 200 Fifth Ave., New York City, moved its office to 25 East 26th St., New York City, on April 24.

The Uehling Instrument Co. of Paterson, N. J., announces the appointment of W. B. McBurney, 619 Trust Co., Georgia Bldg , Atlanta, Ga., as its representative for Georgia and eastern Tennessee.

Hall-Will Inc., Erie, Pa., announce their entrance into the manufacturing field of modern pipe-threading machinery June 1. Leslie Hall, formerly vice-president and general manager of the Williams Tool Corp., is president.

The Homestead Valve Manufacturing Co., Homestead, Pa., has appointed Geo. H. Fredericks & Co., 216 West Water St., Milwaukee, Wis., as its agent in Milwaukee and the surrounding territories.

The A. F. Brown Co., engineers, founders and machinists, with main offices and works at Elizabethport, N. J., announces the removal of their engineering and sales departments from 79 Barclay St., New York, to the Elizabethport plant.

The King Refractories Company, of Buffalo, N. Y., manufacturer of boiler baffles and high temperature cement, announces the appointment of H. O. Price, 413 Union Trust Bldg., Pittsburgh, as its representative.

The Foote Bros. Gear & Machine Co., 215 North Curtis St., Chicago, Ill., at a recent meeting re-elected W. C. Davis as president and treasurer and E. H. Vogt, former auditor and credit manager, as secretary and assistant treasurer.

The Chuse Engine & Manufacturing Co., Mattoon, Ill., announces that it has opened a general Eastern sales office at 50 East 42d St., New York City, in charge of C. L. Clary, eastern sales manager. Mr. Clary was formerly district manager at St. Louis, Mo., for the company.

The American Engineering & Sales Corp. announces the opening of its offices at 1317 F Street, N.W., Washington, D. C., with branch offices at 25 Fifth Ave., New York City, and Rialto Bldg., San Francisco. The president of the new organization is Walter N. Polakov and the vice-president and secretary is Wallace Clark. A new field has been selected by this organization which will be the extension of the interests of American firms in Europe, and in addition it will install American management systems for European clients. Mr. Clark will have charge of organizing manufacturing in Europe for American clients, and Mr. Polakov will handle the engineering research and development of power and national resources for such projects. Former Senator Marion Butler will handle the legal affairs of the corporation and I. B. Richman will be treasurer.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional meeting at Niagara Falls, May 26-28. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Order of Steam Engineers. W. S. Wetzler, 758 N. 44th St., Philadelphia, Pa. Annual convention at Moose Hall, Philadelphia. June 7-11.

American Refractories Institute. D. A. Texter, 2202 Oliver Bldg., Pittsburgh, Pa. Annual meeting at Bellevue-Stratford Hotel, Philadelphia, Pa. May 12.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

The American Society of Heating and Ventilating Engineers. A. V. Hutchinson, 29 West 39th St., New York City. Annual convention at Lexington, Ky., May 26-28.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Kansas State Association.** H. S. Dukes, School for the Blind, Kansas City, Mo. Convention at Abilene, Kans., May 19-21; **Illinois State Association.** O. Jacobsen, 837, Lakeside, Place, Chicago. Convention at Decatur, Ill., June 2-4; **New England States Association,** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Wisconsin State Association,** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Chicago, May 24-26.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, Atlantic City, May 17-21.

Universal Craftsmen Council of Engineers. 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

Business Notes

The Link-Belt Co., 910 South Michigan Ave., Chicago, Ill., announces that Nelson Brandt has rejoined its sales force and will manage a new branch office in Florida, either at Jacksonville or at Orlando.

The Casey-Hedges Co., at Chattanooga, Tenn., had a fire recently in its works which did some $75,000 worth of damage, almost or fully covered by insurance. The fire occurred in the eastern end of the boiler shop where the boilers are tubed, tested and loaded, but arrangements were promptly made so that no delay in excess of 48 hours will occur in the execution of orders.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	May 3 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.61
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.40@ 1.70
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.00@ 2.15
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	1.10@ 1.40
S. E. Ky.	Louisville	1.35@ 1.65
Big Seam	Birmingham	1.75@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.85@ 3.50
Buckwheat No. 1.	Philadelphia	2.25@ 2.75
Birdseye	New York	1.00@ 2.00

FUEL OIL

New York—May 6, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 27, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.15 per bbl.; 26@28 deg., $2.20 per bbl.; 28@30 deg., $2.25 per bbl.; 30@32 deg., $2.30 per bbl.; 32@36 deg., gas oil, 6c. per gal.; 38@40 deg., 6.5c. per gal.

Pittsburgh—May 3, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6⅝c. per gal.

Dallas—May 1, f.o.b. local refinery 26@30 deg., $1.60 per bbl.

Philadelphia—Apr. 30, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati—May 4, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—May 3, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.40@$1.45 per bbl.; 26@30 deg., $1.45@$1.50; 30@32 deg., $1.60@$1.65.

Boston—May 3, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5¾c. per gal.

New Plant Construction

Calif., Los Angeles—Hauser Packing Co., 2300 East 9th St., awarded contract for the construction of a cold storage plant to C. L. Leck, H. W. Hellman Bldg. $101,560.

Calif., Ojai—City is having plans prepared for the construction of a sewage disposal plant including pumps, sand filter beds, etc. at Signal and Blanche Sts. Estimated cost $25,000. D. S. Miller, Long Beach, is engineer.

Calif., Ojai—Ojai Irrigation Dist., is having plans prepared for the construction of a dam, storage reservoir, 180 x 690 ft. steel penstock, tunnels, etc. Estimated cost $2,000,000. J. B. Lipponcott, Petroleum Securities Bldg., Los Angeles, is engineer.

Calif., Sunnyvale—City Trustee, will receive bids until May 17 for one 600 g.p.m. vertical suspended type pump directed connected to a 3 ph. 60 cycle a.c. induction type motor, against a 200 ft. head.

Conn., Meriden—Connecticut School for Boys, E. S. Boyd, Supt., awarded contract for the construction of a power house, heating plant, laundry, etc. for state school to Immick Co., State St. Exchange. Estimated cost $120,000.

Ill., Chicago—American Amusement Co., 160 North La Salle St., is having plans prepared for the construction of a 7 story hotel, theatre, etc., including cooling plant on North Ave. Estimated cost $2,800,000. J. Eberson, 212 East Ontario St., is architect.

Ill., Chicago—H. Lanski, 77 West Washington St., will soon receive bids for the construction of a 7 story apartment at 1148-1152 Sheridan Road, also 3 story apartment at 5520-5524 Blackstone Ave. Estimated cost $750,000 and $600,000 respectively. M. L. Bein, 64 West Randolph St., is architect.

Ill., Chicago—Medical Arts Club, 30 North Michigan Ave., is having plans prepared for the construction of a 23 story office building at Lake St. and Wabash Ave. Estimated cost $4,500,000. D. H. Burnham & Co., 60 North State St., are architects.

Ill., Chicago—D. Schetnitz, 77 West Washington St., awarded contract for the construction of a 12 story office building at Adams and Franklin Sts. to McLennan Construction Co., 307 North Michigan Ave. Estimated cost $2,000,000.

Ind., Danville—City, H. Towell, Clk., will soon receive bids for boilers, pumps and pumping equipment. Estimated cost $7,000. R. W. Noland, Lafayette, is engineer.

La., Franklin—City voted $150,000 bonds improvements to waterworks including power plant and distribution system. H. A. Mentz, Hammond, is engineer.

Mass., Boston—The Embassey, Inc., c/o J. S. Draper, 209 Washington St., is receiving bids for the construction of an 11 story apartment on Beacon St. Estimated cost $1,250,000. R. H. Doane, 162 Newbury St., is architect.

Mass., Boston—Fort Point Building Trust, c/o M. C. Burton, 1 Federal St., plans the construction of a 13 story office building at Congress St. and Fort Point Channel. Estimated cost $2,000,000. Blackall, Clapp & Whittemore, 31 West St., are architects.

Mass., Holyoke—Gas & Electric Dept., City Hall, awarded contract for the construction of a boiler house to P. J. Kennedy Co. Inc., 46 Park St. Estimated cost $40,000.

Mass., Springfield—Westinghouse Electric & Mfg. Co., Page Blvd., East Springfield, will soon award contract for the construction of a 4 story addition to plant. Estimated cost $150,000. Power equipment will be required.

Minn., St. Cloud—Schmidt, Garden & Martin, 104 South Michigan Ave., Archts., will receive bids about May 15 for the construction of a 6 story hospital for Sisters of Order of St. Benedict, St. Joseph. Estimated cost $1,500,000.

Mo., St. Louis—Water Dept., A. Pritchard, Dir. of Public Utilities, had preliminary plans prepared for superstructures of boiler house, coal receiving house, intake house, pumping plant, etc. at Howard's Bend on the Missouri River.

Mo., Springfield—Ozark Hydro Electric Co., is having plans prepared for the construction of a 70 ft. dam on Crooked Creek about one mile from Yelleville. C. H. Lavasseur, is engineer.

N. H., Rochester—Rochester Realty Co., c/o Dow, Harlow & Kimball, 184 Boylston St., Boston, Mass., Archts., is receiving bids for the construction of a 3 story apartment, stores and office building including power plant at Hanson, Wakefield and Autumn Sts., here.

N. J., Trenton—Public Service Corp., 80 Park Place, Newark, plans the construction of an electrical building at Paul's Grove here. Estimated cost $60,000.

N. Y., Kings Park—State Hospital Commission, Capitol, Albany, will receive bids until May 26 for 2 electric generators, air compressor, etc. for Kings Park State Hospital. S. W. Jones, Capitol, Albany, is state architect.

N. Y., New York—Calvary Baptist Church Corp., 123 West 57th St., awarded contract for the construction of a 15 and 30 story church and hotel, to R. M. Catts Corp., 247 Park Ave. Estimated cost $2,500,000.

N. Y., New York—Duo Building Corp., c/o J. M. Felson, 250 West 57th St., Archt., will build an apartment on Webster Ave. by day labor. Estimated cost $900,000.

N. Y., Pittsford—Sisters of St. Joseph, c/o J. Flynn, 217 East Ave., Rochester, Archt., is receiving bids for the construction of a power house and boiler room for Nazareth College here. Estimated cost $750,000.

N. C., Shelby—City plans the construction of a pumping station, 6,000,000 gal. capacity. Estimated cost $165,000.

N. D., Washburn—Ottertail Power Co., Fergus Falls, Minn., awarded contract for the construction of a 12,000 hp. steam power plant, here, to Siems, Helmers & Schaffner, Inc., 514 Guardian Life Bldg., St. Paul, Minn.

O., Dayton—Caldwell & Son, Indianapolis, Ind., is having plans prepared for the construction of a 13 or 15 story hotel at Main and First Sts., here. Estimated cost $2,000,000. F. J. Hughes Co., J. B. Bldg., Dayton, O., is architect.

Okla., Mangum—M. H. Pace, 437 South Pace St., will build a cotton gin by day labor. Estimated cost $35,000. Private plans. Owner is in the market for power plant and cotton gin equipment.

Ore., Portland—C. A. Houghtaling, Gearing Bldg., Archt., has prepared plans for the construction of an 8 story apartment and hotel building at 19th, Flanders and Glisan Sts. Estimated cost $1,400,000. Owner's name withheld.

Pa., Philadelphia—Pennsylvania R.R. Broad St. Station, awarded contract for the construction of a 9 story office and stores building at 1107-1108 Market St. to Irwin & Leighton, 126 North 12th St. Estimated cost $300,000.

Pa., Philadelphia—Transit Dept., H. E. Ehlers, Dir., 1211 Chestnut St., will receive bids until May 18 for furnishing and installing synchronous converters and transformers for Mt. Vernon, Cumberland and Lauden sub-stationes of the Broad Street subway.

Tenn., Columbia—Maury County Ice Co., Columbia, plans the construction of an ice plant. Estimated cost $40,000.

Tex., Amarillo—City is having plans prepared for the construction of a waterworks system including new wells, two pumping stations, 5,000,000 gal. reservoir, etc. Estimated cost $1,000,000. W. Kiersted, 611 Interstate Bldg., Kansas City, Mo., are engineers.

Tex., Austin—University of Texas, Bd. of Regents, H. J. L. Stark, Chn. and J. W. Calhoun, Comptroller, will receive bids until May 15 for two 300 hp. and three 500 hp. boilers, mechanical stokers, coal and ash handling equipment, boiler feed pumps, vacuum pumps, centrifugal pumps, uniflow steam engine, generator, Zeolite water treating plant, feed water heaters, etc. H. C. Weaver, is engineer.

Tex., Freeport—Freeport Light, Water & Ice Co., is having preliminary plans prepared for improvements to waterworks including a pump house, centrifugal pump, etc., to increase the capacity from 250 to 750 g.p.m. Estimated cost $15,000.

Tex., Marshall—City voted $50,000 bonds for improvements to waterworks including pumping equipment, mains, etc. P. M. Herndon, Secy.

Tex., Mineral Wells—Mineral Wells Hotel Co., c/o A. E. Eaton, plans the construction of a 12 story hotel at First Ave. and Hubbard St. Estimated cost $1,000,000.

Tex., Pharr—Delta Cold Storage Co., will build a cold storage plant by day labor. Estimated cost $30,000. Private plans. Refrigeration and packing machinery will be required.

Tex., Port Arthur—City, J. C. Hamilton, Clk., will receive bids until May 13 for furnishing and installing one 10,000 g.p.m. low service motor driven pump and one 2,100 g.p.m. high service pump. J. O. Herpin, is engineer.

Tex., Victoria—Baker Hotel Co., c/o T. B. Baker, Gunter Hotel, San Antonio, is having preliminary plans prepared for the construction of a 7 story hotel here. Estimated cost $500,000. H. S. Green, Alamo National Bank Bldg., San Antonio, is architect.

Wis., Milwaukee—Sisters of the Sorrowful Mother, Marshfield, awarded contract for the construction of a 4 story convent including power house, laundry, etc., on Cedarburg Road, here, to Hutter Construction Co., 128 Western Ave., Fond du Lac. Estimated cost $450,000.

Wis., Shawano—Wisconsin Power & Light Co., 16 North Carroll St., Madison, is having plans prepared for the construction of a hydro electric plant on Wolf River here. Estimated cost $50,000. Private plans.

Wis., Soldiers Grove—Interstate Power Co., H. O. Ortin, Mgr., Dubuque, Ia., is having plans prepared for the construction of a hydro electric plant here. Estimated cost $75,000. Private plans.

Wis., Tayceedah—State Bd. of Control, A. W. Bayley, Secy., Madison, is having plans prepared for two refrigeration plants including machinery, etc., at Wisconsin Industrial Home, here. A. Peabody, is engineer

Wis., Trego—Wisconsin Hydro Electric Co., E. J. Schneider, Pres., Amery, awarded contract for the construction of a hydro electric plant and dam on the Namakagon River here to Siems, Helmers & Schaffner, Guardian Life Bldg., St. Paul, Minn. Estimated cost $70,000.

Wis., Wausau—Wisconsin Distributing Co., W. Shapiro, Pres., is in the market for a new chemical refrigeration plant and machinery for fruit warehouse.

Wis., Weyauwega—Waupaca County, R. M. Hanson, Secy. of Committee, Scandinavia, will soon award contract for the construction of a boiler house, laundry, etc., for Insane Asylum. Estimated cost $45,000. R. Cramer, 448 27th St., Milwaukee, is engineer.

Ont., Fort Frances—Seine River Improvement Co., awarded contract for the construction of a power plant to Backus-Brooks Construction Co. Estimated cost $1,000,000.

Ont., London—J. M. Moore, 489 Richmond St., Archt., will soon award contract for the construction of a hotel. Estimated cost $1,000,000.

Australia, Melbourne—State Electricity Commission of Victoria, 32 William St., will receive bids until June 28 for three 250 kva., six 100 kva., six 50 kva., three 25 kva. and three 15 kva. transformers, also one complete set spare high and low v. coils and necessary insulation, one complete set of spare high v. and one complete set of spare low v. bushings for one transformer of each rating.

Australia, Melbourne—Victorian Government Railways, will receive bids until June 16 for one heavy current motor generator set.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

WITH the exception of slight fluctuations in prices of babbitt metal, linseed oil and cotton waste, most of the power-plant supplies remained fairly steady during the past month. Electrical supplies showed no price changes of consequence. The new standardized Mazda lamp list, shown in part on p. 738, necessitates quotations on fewer types as against a great amount of detail formerly.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 74c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	40%

Air—Best grade

¾-in., per ft.	3-ply	$0.37½	4 ply	$0.45

Steam—Discounts from List

First grade 30-10% Second grade 40% Third grade 40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 50-10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40-5%
Heavy	30-10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$1.05
Asbestos for high-pressure steam, ⅛ in.	1.85
Duck and rubber for piston packing	1.05
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.95
Wire insertion asbestos sheet	1.40
Rubber sheet	.60
Rubber sheet, wire insertion	.85
Rubber sheet, duck insertion	.65
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@$2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	13.00@17.50	18.00	15.00@20.00
Colored	10.00@14.00	17.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.16
New York	.18
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.84½	$0.96	$1.87

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ⅛x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ½-in. dia., 35c.; ¾-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ½, ⅝, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York $5.00* Chicago $3.50 Pittsburgh $2.50@2.60

Boiler rivets, same sizes:

New York $5.20* Chicago $3.70 Pittsburgh $2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and splits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	48@50
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	43@45
Chrome ore crude, 40@50%	net ton	19.00@20.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	89.87½
Commercial genuine, intermediate grade	56.00
Anti-friction metal, general service	23.50
No. 4 babbitt (f.o.b.)	13.62½

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats and squares, per 100 lb. base	4.50	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3¼	30 25	49 50	30 67
3½	31 50	52 75	33 33
4	38 03	67 00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$33.50 (net)	$ 51 00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft	60%	30%
1,000 to 5,000 ft	60-5%	35%
5,000 ft. and over	60-10%	38%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15 10	17.21	8.39	9.13
1¼	139.77	152.88	20 51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50 13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508 50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75 02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1 00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$21.50
No. 16 cotton reinforced heavy		25 00
No. 18 cotton reinforced light		17.50
No. 16 cotton reinforced light		21.00
No. 18 cotton Canvasite cord		17 25
No. 16 cotton Canvasite cord		21.00
No. 16 super service cord or similar (2 wire) in 1,000 ft	$92.00	*101.20
No. 14 super service cord or similar (2 wire) in 1,000 ft	133.00	*146.40

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	30	35-amp. to 60-amp.,	100	.60
61-amp. to 100 amp.,	50	90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%, standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16 00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
Decorative			Special		
15	A 17	$0.27	25	A 19	$0.32
General			50	A 21	.32
25	A 19	.27	100	A 23	.55
40	A 21	.27			
50	A 21	.29			
60	A 21	.32			
100	A 23	.45			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6.70	$9.75	$11 60	$18.20
12	10.10	12.60	14 60	23.80
10	13.20	16 40	18 60	30 50
8	19 00	22 30	24 20	42.40
6	.....	.....	34 40	.....
4	.....	.....	48 00	.....
2	.....	.....	68 75	.....
1	.....	.....	94 70	.....
0	.....	.....	115 00	.....
00	.....	.....	138 00	.....
000	.....	.....	165 00	.....
0000	.....	.....	196 00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each Net	Keyless Each Net	Pull Each Net	¾ In. Cap Key Each Net	Keyless Each Net	Pull Each Net
$0.18*	$0.17*	$0.22*	$0.21*	$0.20*	$0.25*
.20†	.19†	.24†	.24†	.23†	.27†
.23‡	.22‡	.27‡	.27‡	.25‡	.30‡

*Less than one-fifth of standard package.
†One-fifth up to full standard package.
‡Full standard package.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c lb.
Wire solder, less 100 lb. 29c. lb., 100 lb. lots	31c lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30-5%
$50 list value or over	35%